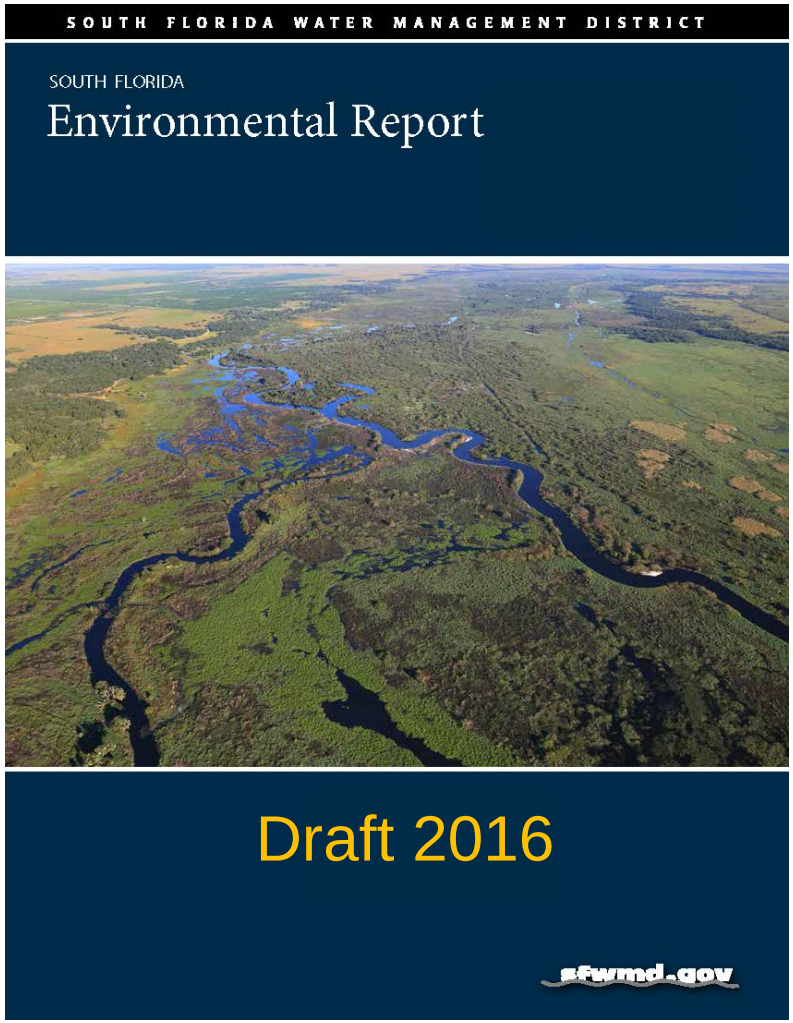
Past & Present Water Quality Conditions in the South Florida Water Management District

November 5, 2015
(Revised 12/23/15)

Stuart Van Horn, P.E. – Chief, Water Quality Bureau

Information Source



- Annual Report published by May 1st
  - Florida Department of Environmental Protection
  - South Florida Water Management District
- Details a Year of Accomplishments in Restoration, Science and Engineering
  - Southern Everglades (Vol. I – Ch.'s 3, 4, 5, 6)
  - Lake Okeechobee Watershed (Vol. I - Ch. 8)
  - Kissimmee Watershed (Vol. I - Ch. 9)
  - Coastal Watersheds and Estuaries (Vol. I - Ch. 10)
- DRAFT Report available at:

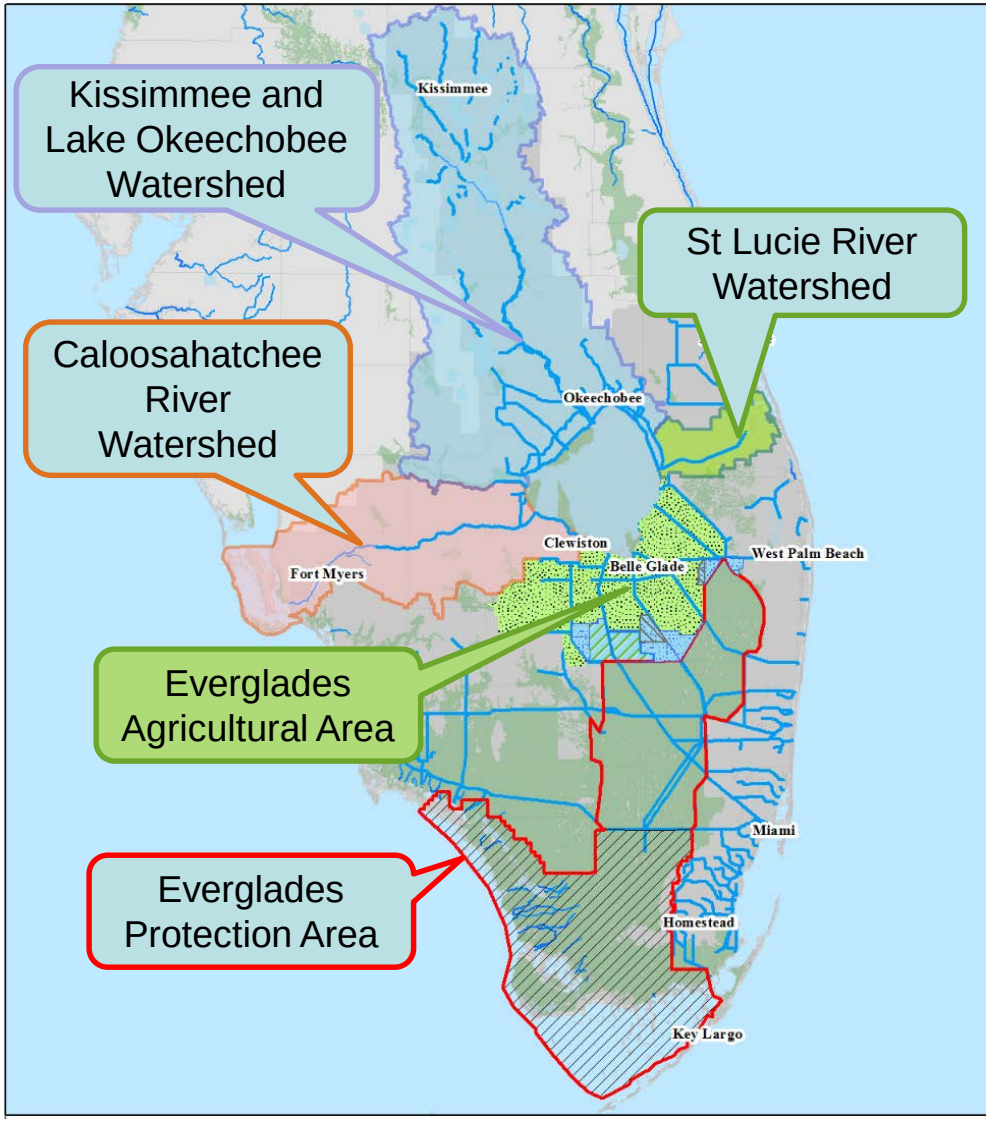
  www.sfwmd.gov/sfer

  Water Year 2015 (May 1, 2014 – April 30, 2015)

Presentation Outline

Past & Present Total Phosphorus Conditions

- Southern Everglades
  - Everglades Protection Area
  - Everglades Agricultural Area
- Northern Everglades
  - Kissimmee and Lake Okeechobee Watershed
  - St Lucie River Watershed
  - Caloosahatchee River Watershed
- Summary

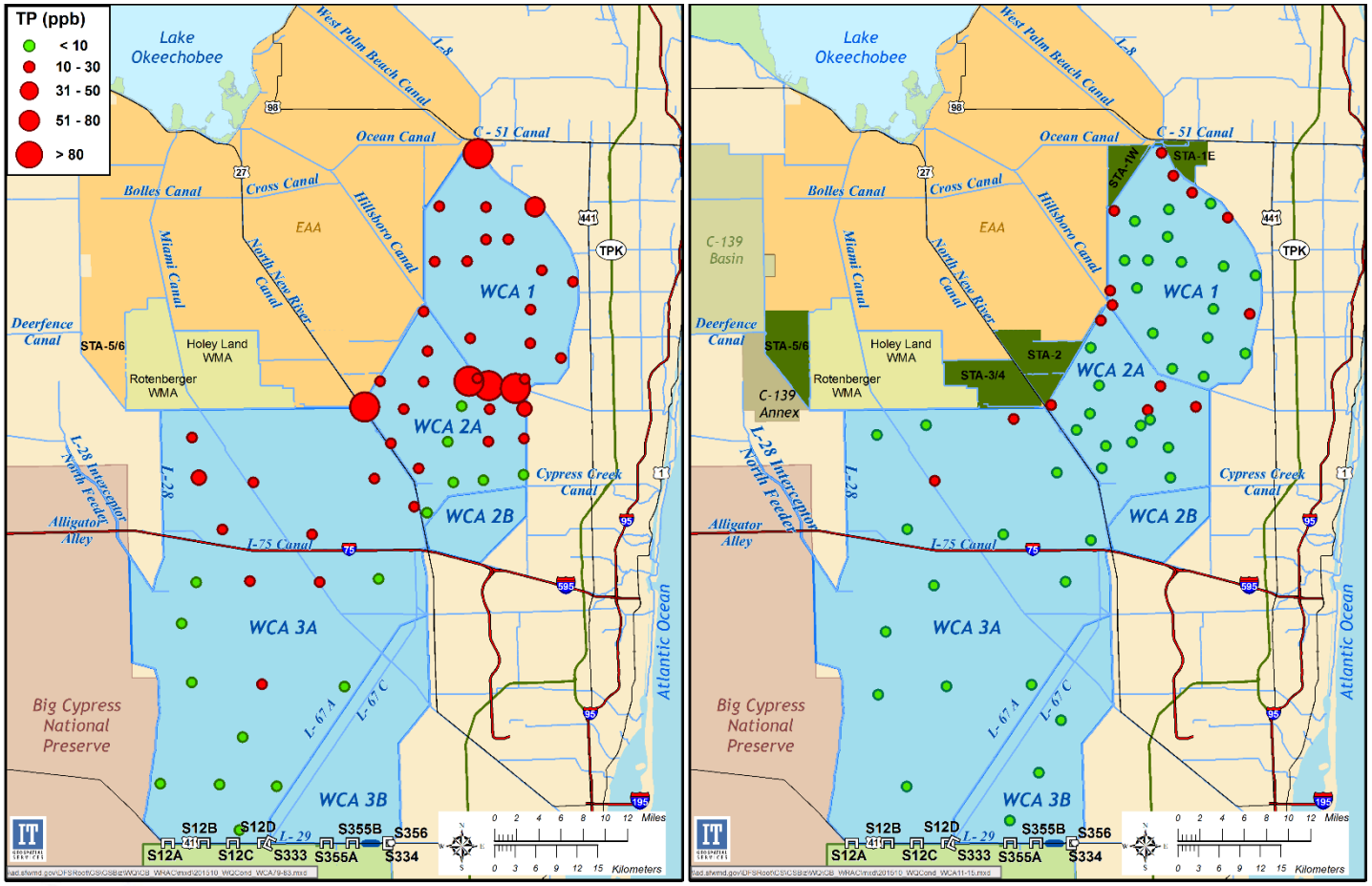


Southern Everglades

Water Quality Improvement in Total Phosphorus (TP) Concentrations in the Water Conservation Areas (WCAs)

WY1979-1983
High TP in WCAs

WY2011-2015
Majority of area below
10 parts per billion (ppb)



Significant decrease in TP inflow to WCAs as a result of the 1994 “Everglades Forever Act” requiring:

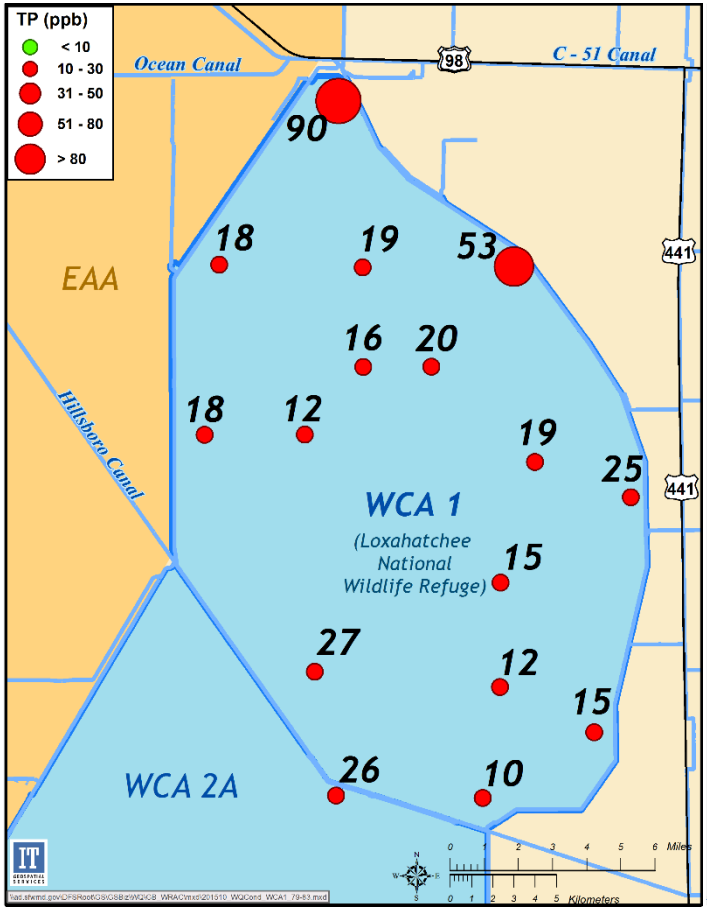
- On-Farm Best Management Practices (BMPs)
- Stormwater Treatment Areas (STAs)
- Comprehensive research program to optimize both BMP and STA performance

NOTE:
TP values represent the 5-year average of annual geometric means at each station

Southern Everglades

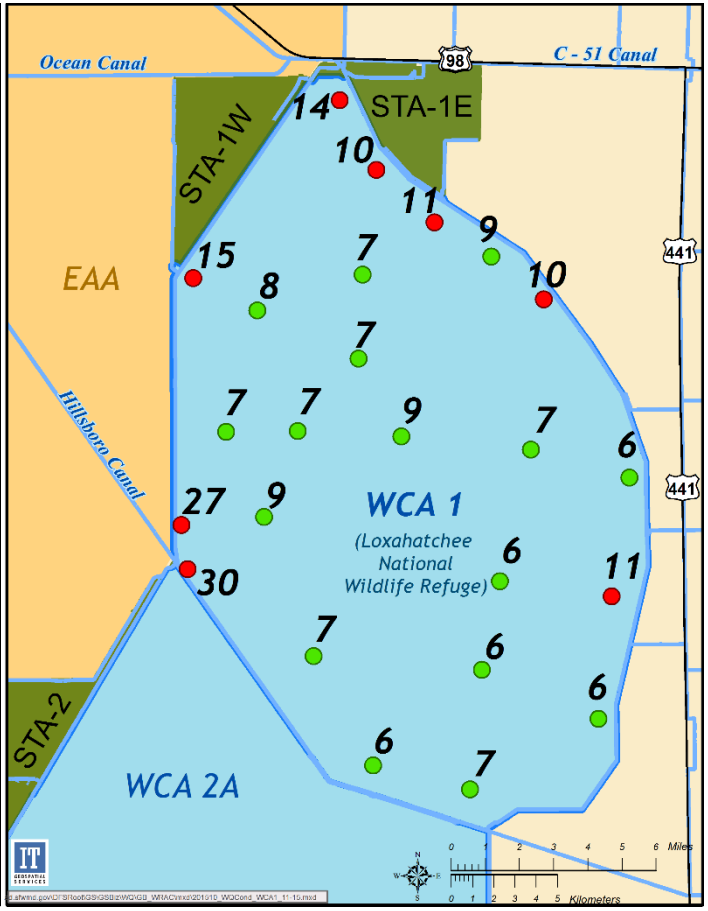
TP Concentration Improvement in the Loxahatchee Refuge (WCA-1)

WY1979-1983
All sites > 10 ppb



Mean of CA1-3 to CA1-16: 20.4 ppb

WY2011-2015
Most sites < 10 ppb

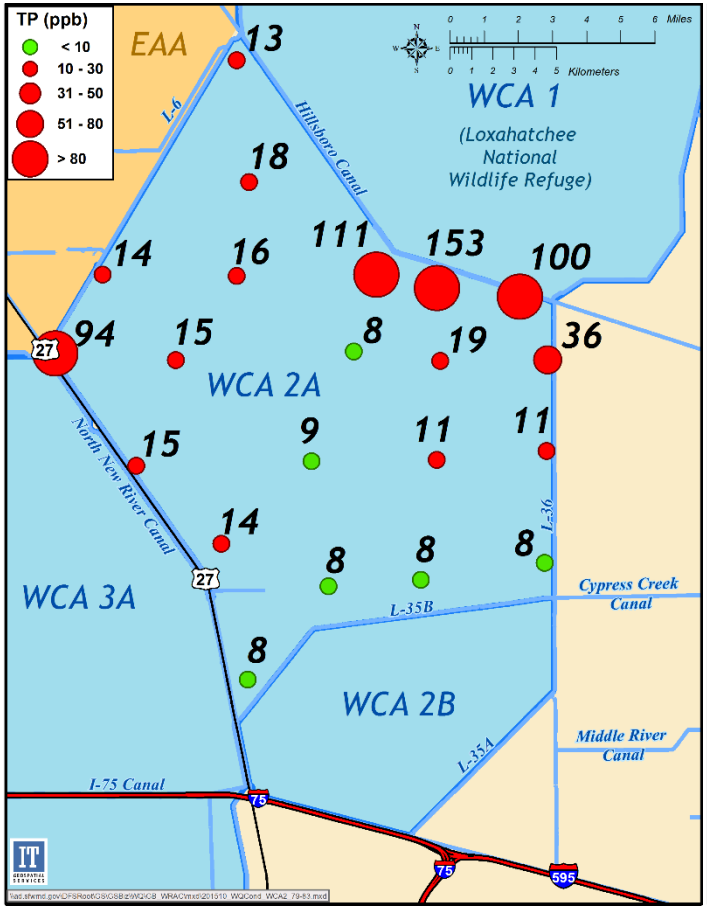


Mean of LOX3 to LOX16: 6.9 ppb

NOTE:
TP values represent the 5-year average of annual geometric means at each station

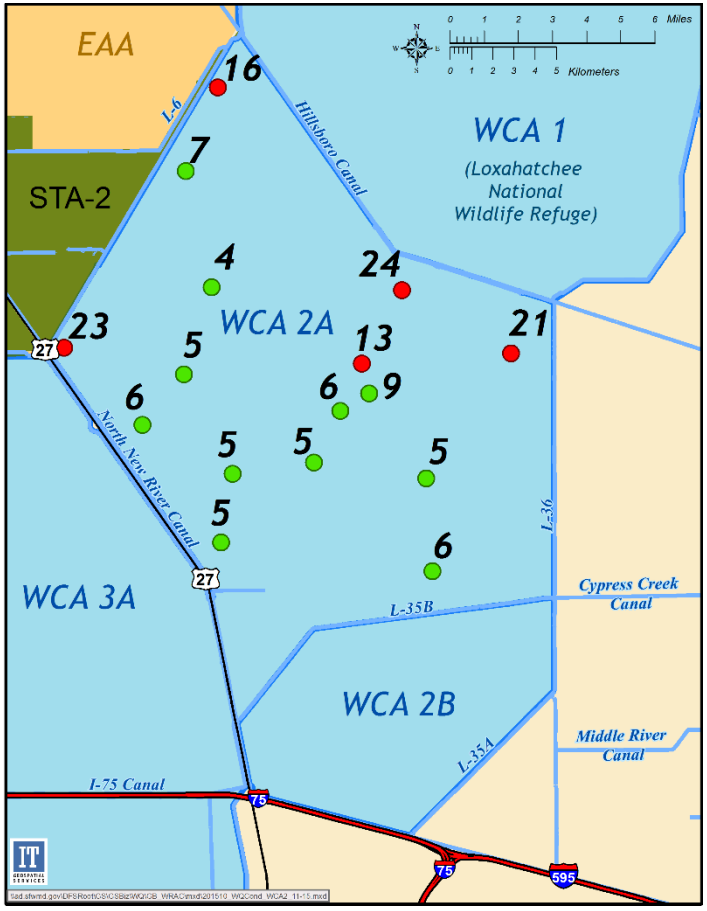
Southern Everglades
TP Concentration Improvement in WCA-2A

WY1979-1983
71% of sites > 10 ppb



Mean of all 21 stations: 32.8 ppb

WY2011-2015
All sites significantly improved
31% of sites > 10 ppb

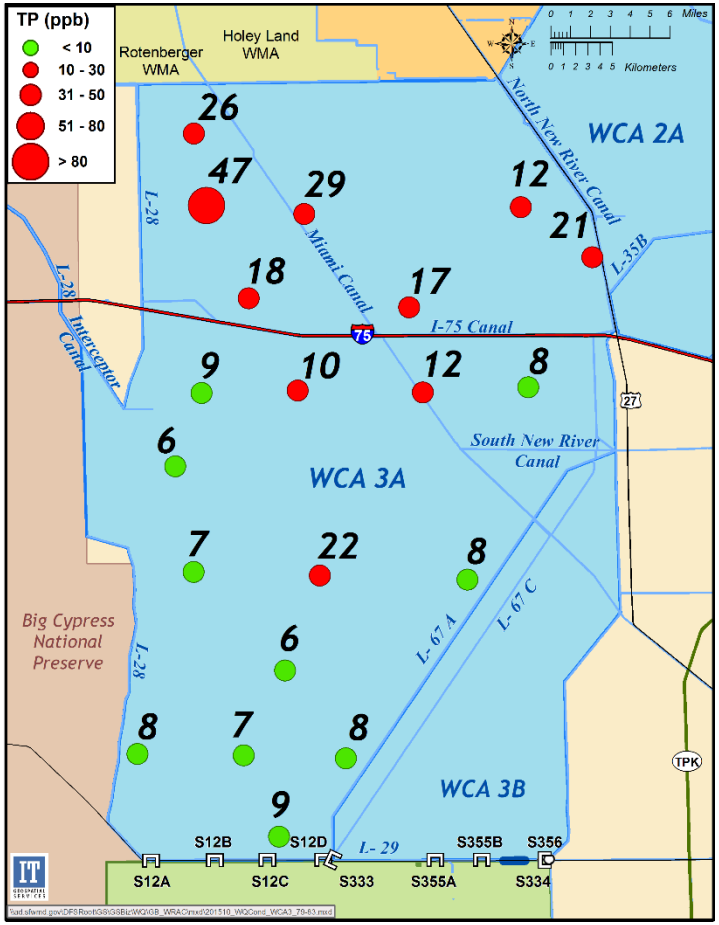


Mean of all 16 P-Rule stations: 9.9 ppb

NOTE:
TP values represent the 5-year average of annual geometric means at each station

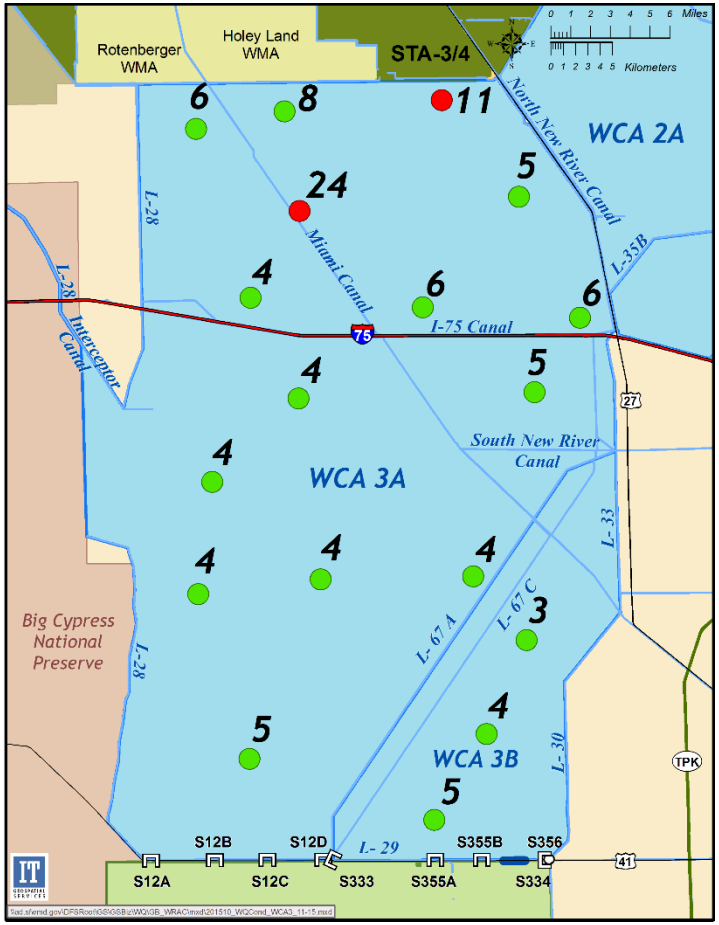
Southern Everglades
TP Concentration Improvement in WCA-3

WY1979-1983
~50% of stations > 10 ppb



Mean of all stations (CA3-1 to CA3-21): 14.5 ppb

WY2011-2015
Only two stations > 10 ppb



Mean of all 18 P-Rule stations: 6.2 ppb

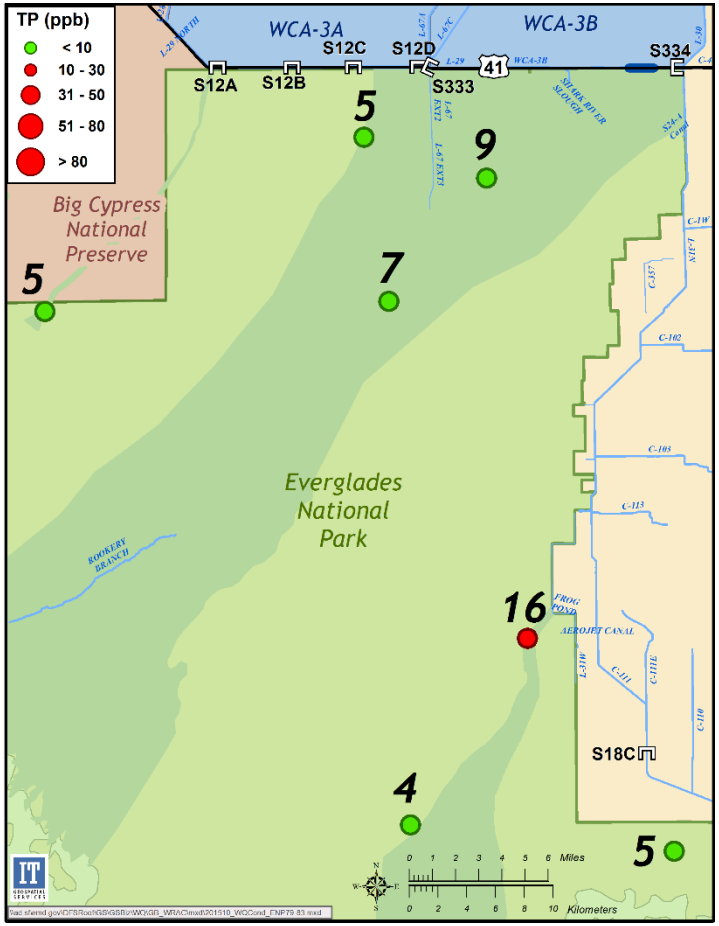
NOTE:
TP values represent the 5-year average of annual geometric means at each station

Southern Everglades

TP Concentration Improvement in Everglades National Park (ENP)

WY1986-1990

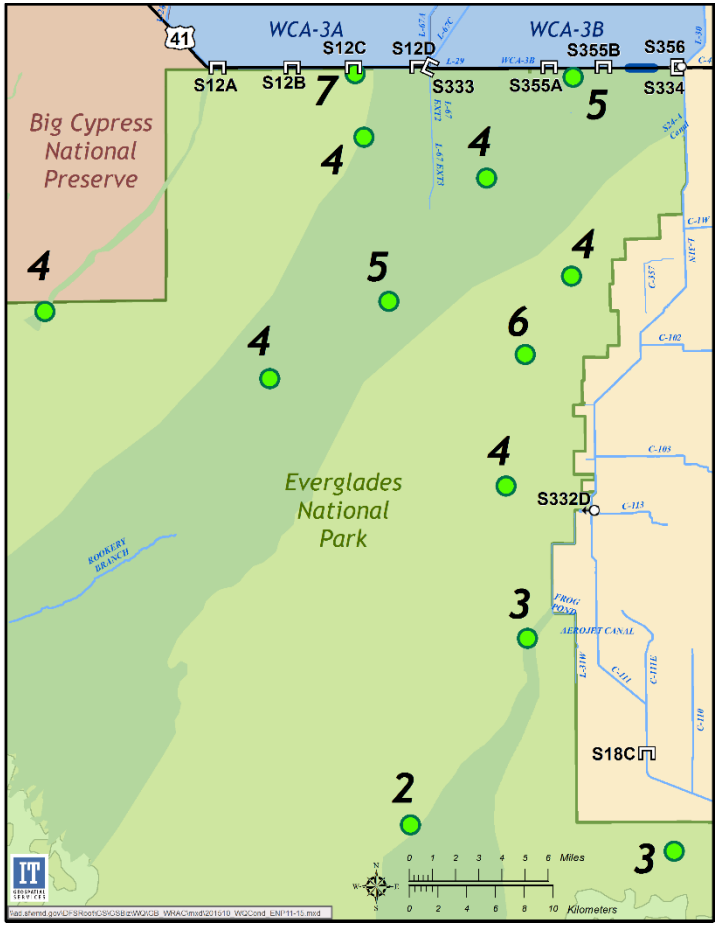
Most stations >= 5 ppb



Mean of all 7 stations: 7.2 ppb

WY2011-2015

Most stations <= 5 ppb



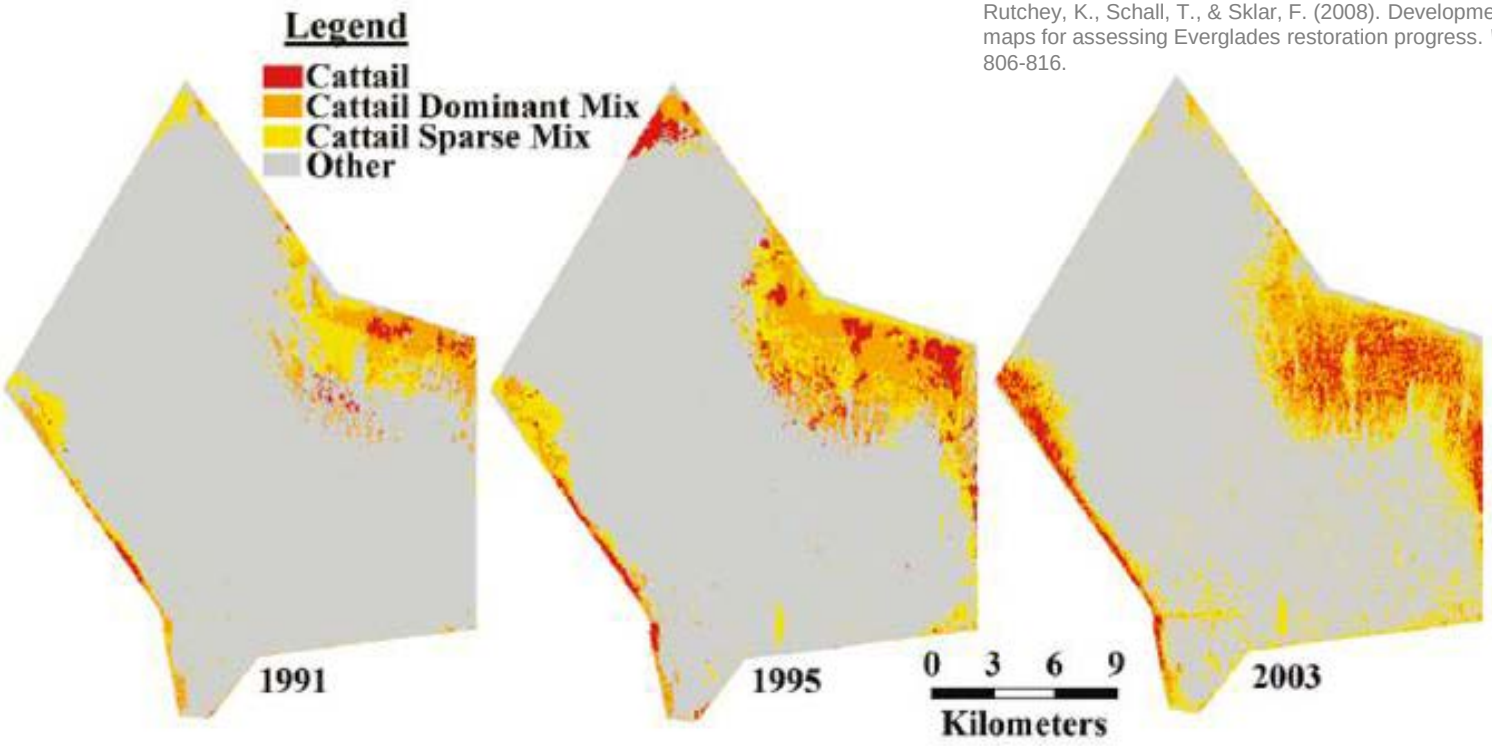
Mean of all 13 P-Rule stations: 3.6 ppb

- TP concentrations at sites in the ENP have consistently remained below 10 ppb.

NOTE:
TP values represent the 5-year average of annual geometric means at each station

Southern Everglades
WCA-2A Vegetation Changes

Source:
Rutchey, K., Schall, T., & Sklar, F. (2008). Development of vegetation maps for assessing Everglades restoration progress. *Wetlands*, *28*(3), 806-816.



The argument in 1988 was that cattails were expanding 5 acres per day and ultimately would take over the entire Southern Everglades.

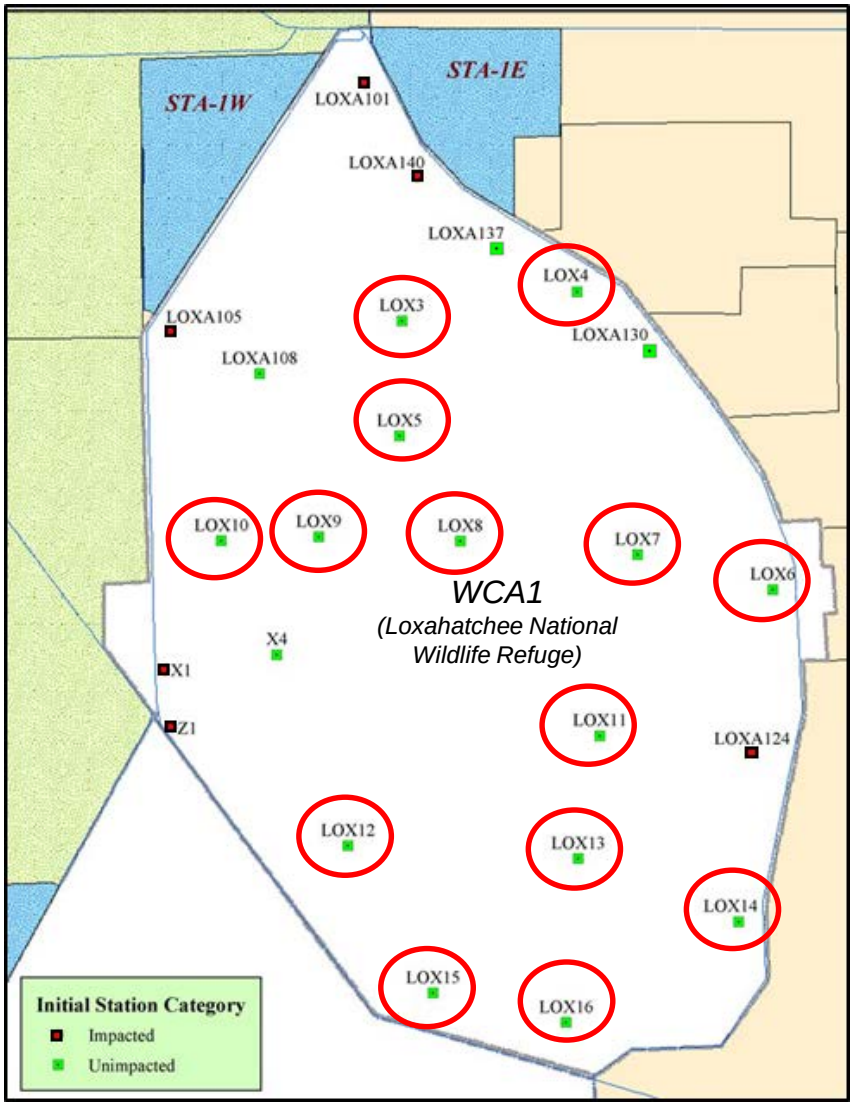
Over the last 20 years there has been little expansion of cattail areas in WCA-2A.

The cattails are there primarily due to high phosphorus soils. Physical removal is a management option being actively studied.

Southern Everglades
Exceedances in the Everglades (Loxahatchee Refuge)

Loxahatchee National Wildlife Refuge Applicable TP Criteria

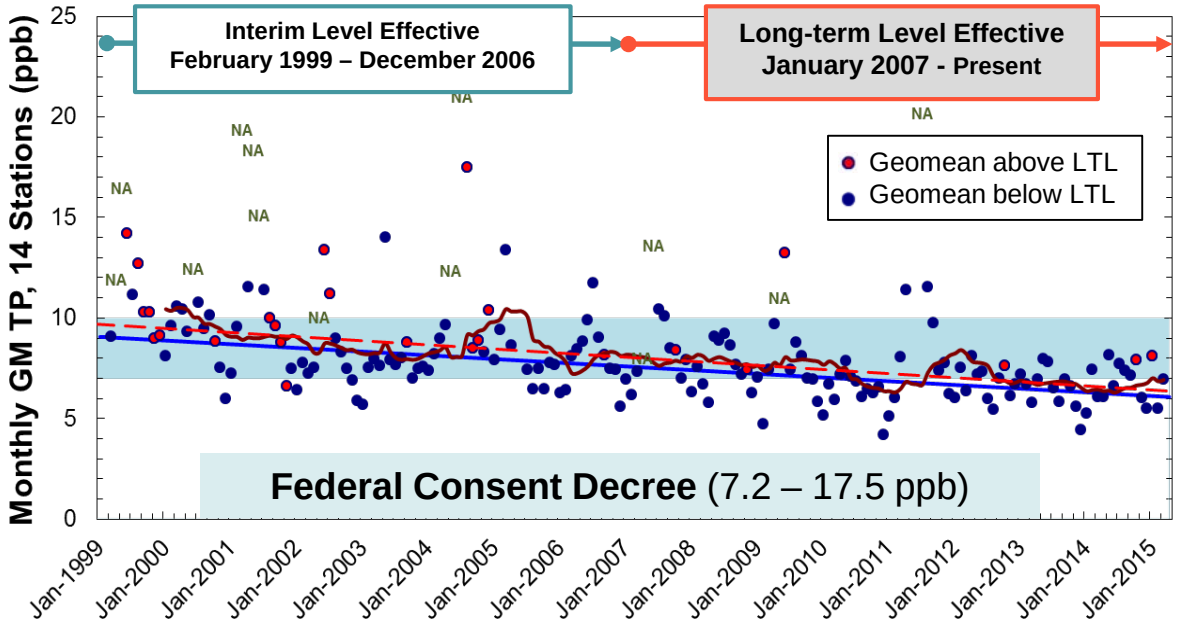
- Federal Consent Decree (Appendix B)
  - 14 station TP geometric mean (long-term goal ~7ppb)
    - Long-term compliance level varies (7.2-17.5 ppb) dependent on water level
    - Tested monthly
- State TP Rule
  - 18 Unimpacted station TP geometric mean
  - 6 Impacted station TP geometric mean
    - Long-term compliance limit (10 ppb)
    - Tested annually and on 5-year basis



Southern Everglades
Exceedances in the Everglades (Loxahatchee Refuge)

Federal Consent Decree (Appendix B)

- Actual 14-station geo-mean downward trend:
  - 1999 geometric mean ~10 ppb
  - 2015 geometric mean ~ 7 ppb
- Monthly TP averages for 5-yrs (Oct 2010-Sep 2015):
  - ~ 95% of months below level by 3.7 ppb
  - ~ 5% of months above level by 0.4 ppb



Monthly 14-Station Geometric Mean TP Concentrations Deviation from Long-term Levels (LTL) in ppb (October 2010 – September 2015)

	Number of Months	Minimum Difference	Maximum Difference	Average Difference
In-Compliance (below level)	53	-0.2	-9.4	-3.7
Excursion (above level)	3	0.2	0.7	0.4

Note: The laboratory margin of error is +/- 2 ppb

Exceedance Event TP Differences in ppb

	Actual	Long-term Level	Difference
2008 Nov	7.4	7.2	0.2
2009 Jun	13.2	12.1	1.1
2014 Oct	7.9	7.2	0.7
2015 Jan	8.1	7.9	0.2

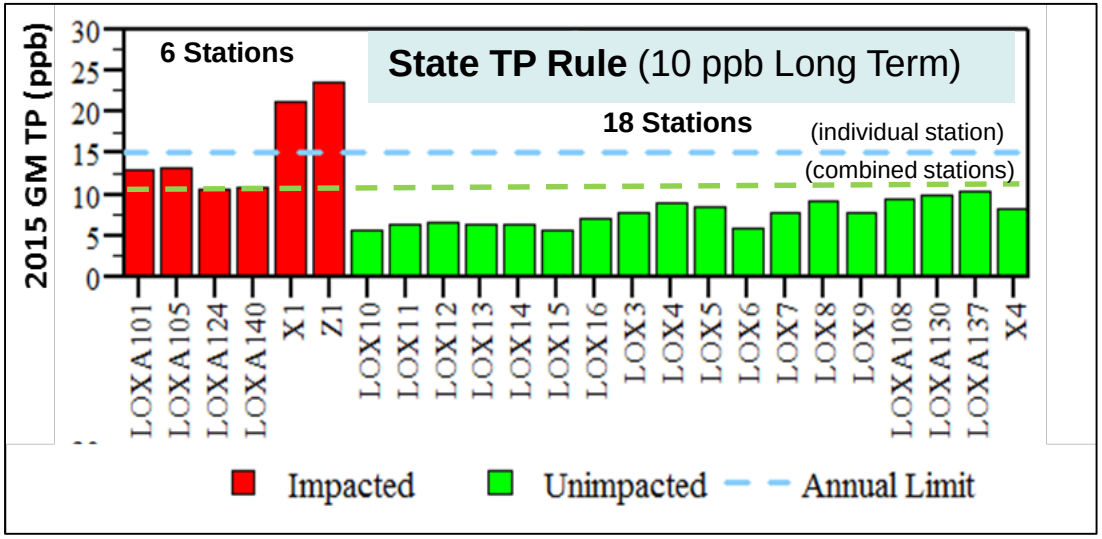
Note: Two monthly Excursions in 12-month period result in an Exceedance of long-term compliance level.

Southern Everglades
Exceedances in the Everglades (Loxahatchee Refuge)

State TP Rule (WY2015)

- Unimpacted 18-stations
  - All 4 parts of compliance test met
  - Average geometric mean ~ 7 ppb
- Impacted 6-stations
  - 4 stations met annual individual test
  - Average geometric mean ~15 ppb

WY2015 TP Geometric Means (GM) in ppb



TP Rule 4-part Compliance Test

Criterion Provision	Applied to	Test
5-year Average Geometric Mean	All Stations GM	≤ 10 ppb
3 of 5 years	All Stations GM	≤ 10 ppb
Annual	All Stations GM	≤ 11 ppb
Annual	Individual	≤ 15 ppb

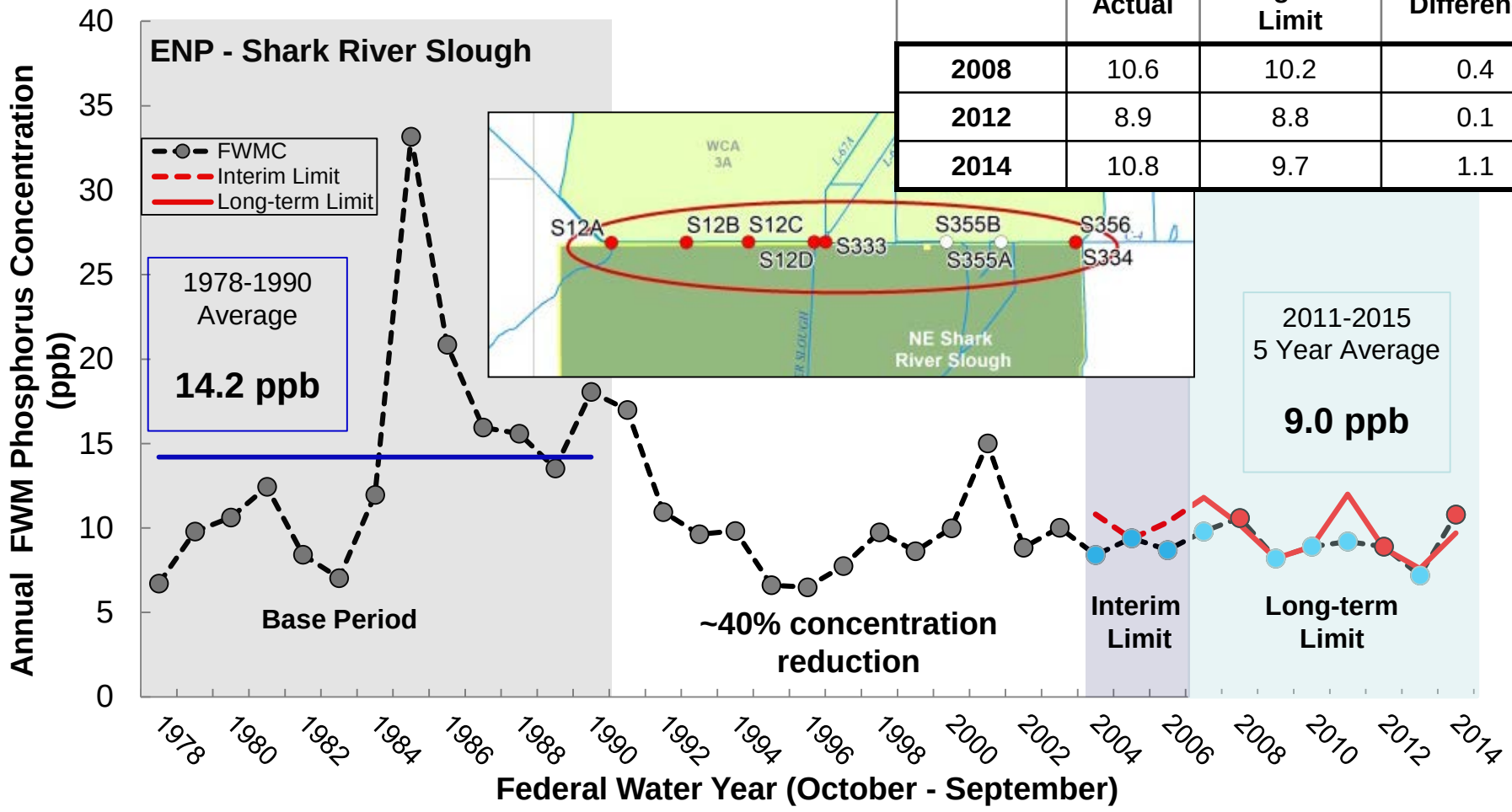
Note: Test is applied to Impacted and Unimpacted sites separately

Southern Everglades
Exceedances in the Everglades (Shark River Slough)

Federal Consent Decree (Appendix A)

Exceedance Event TP Differences in ppb

	Actual	Long-term Limit	Difference
2008	10.6	10.2	0.4
2012	8.9	8.8	0.1
2014	10.8	9.7	1.1

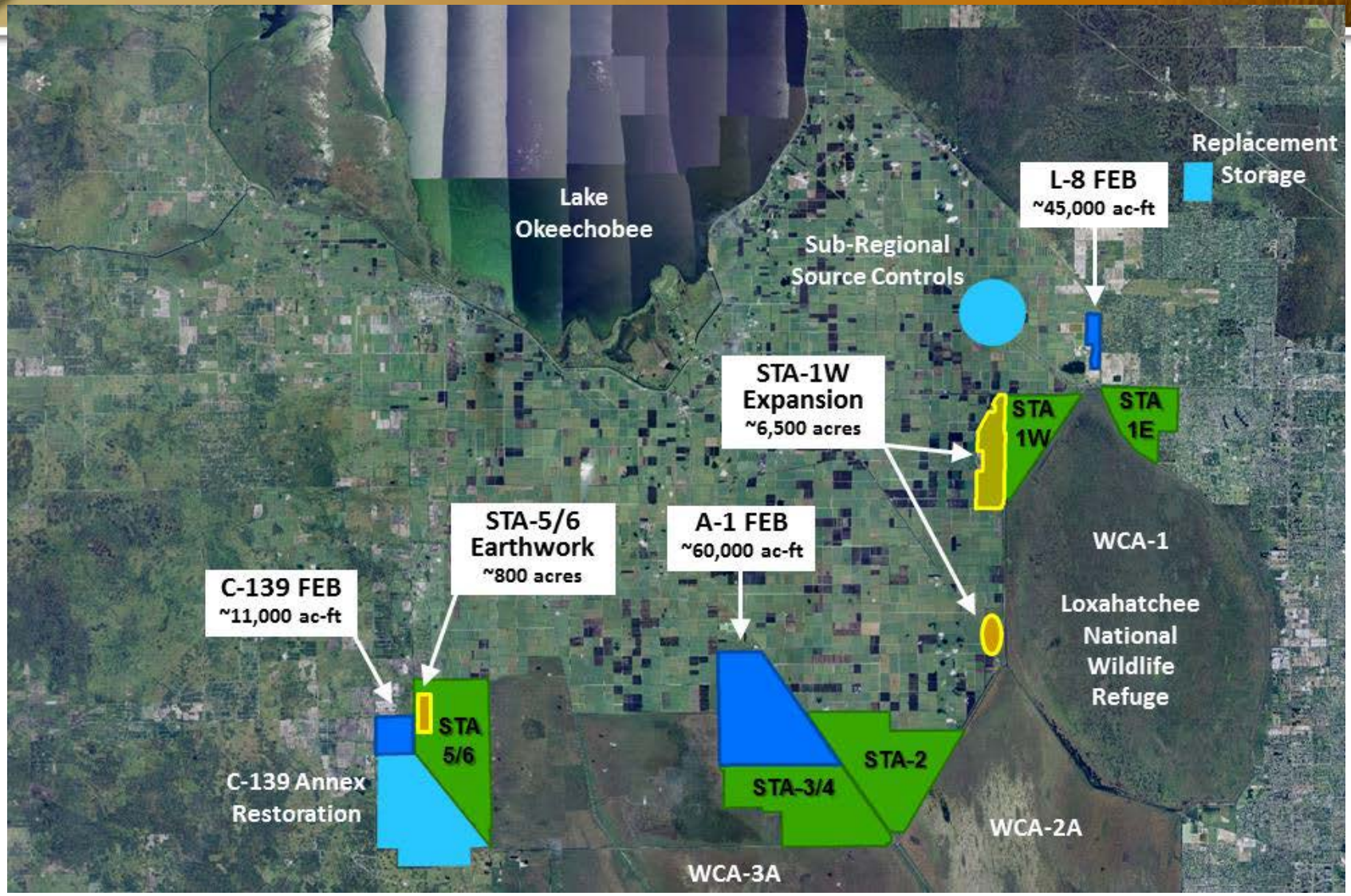


FWMC – flow weighted mean concentration

Note: The laboratory margin of error is +/- 2 ppb

Everglades Agricultural Area

Everglades Construction and Restoration Strategies Projects

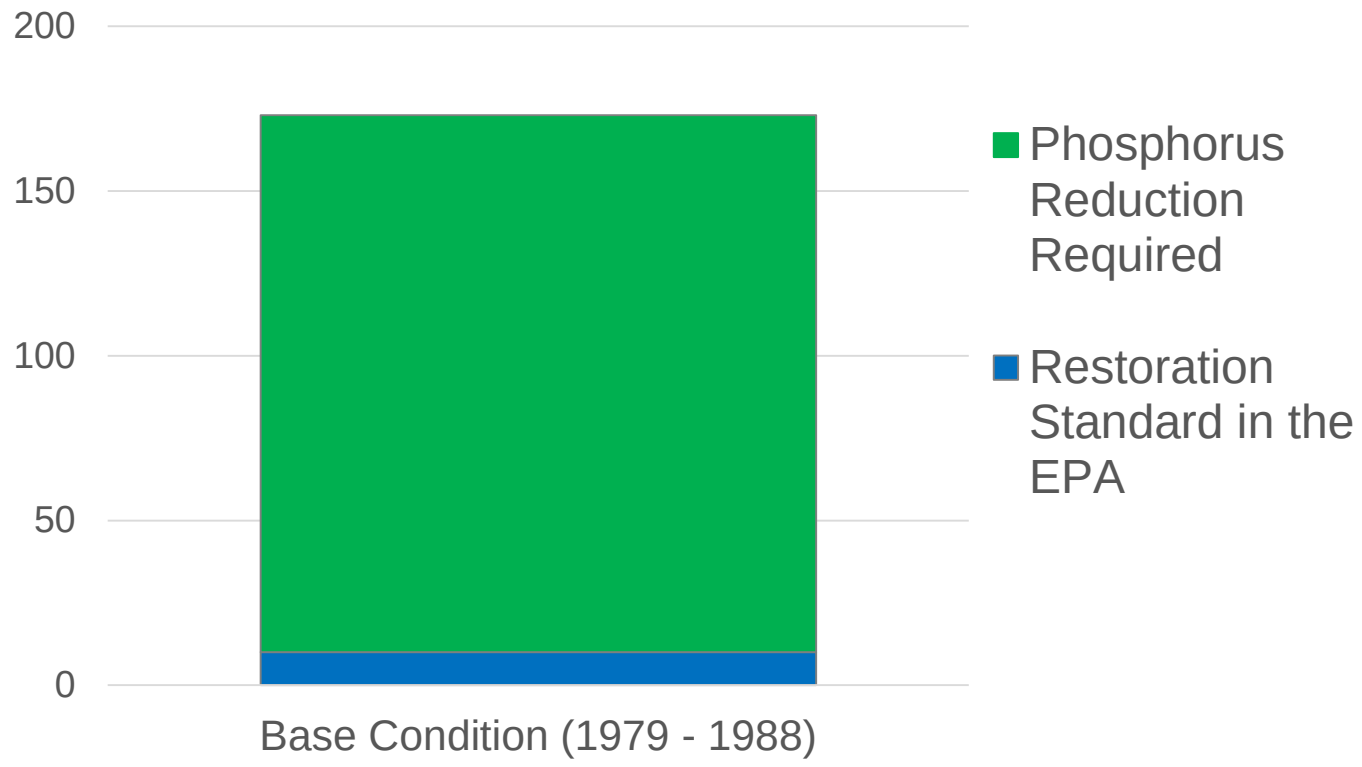


Source: Figure 5A-1 Key Projects for the Restoration Strategies Regional Water Quality Plan (Draft 2016 SFER)

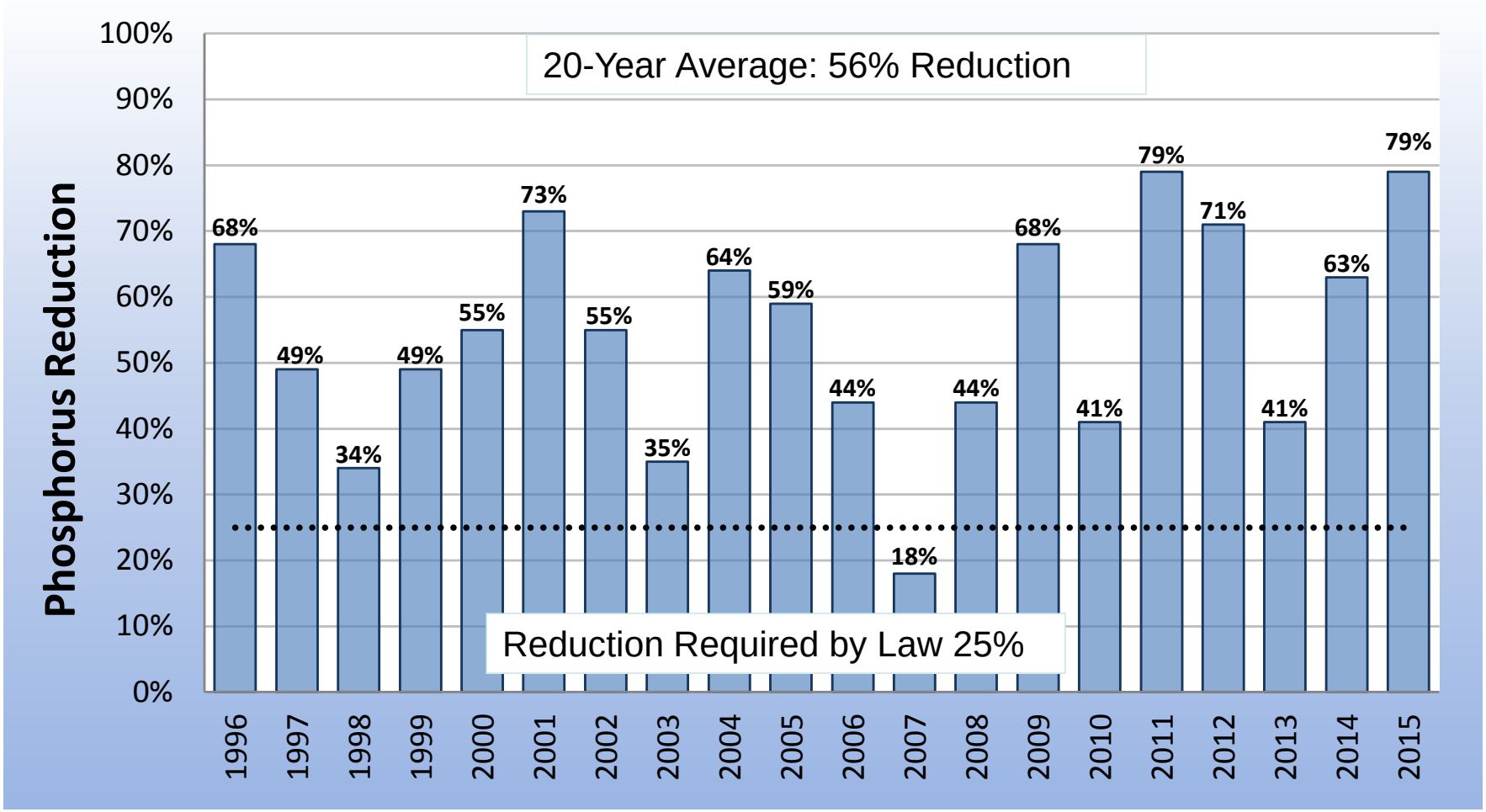
Everglades Agricultural Area
Legal Requirements for Phosphorus Reduction

State Law requires a long-term geometric mean of 10 µg/L or ppb TP for the Everglades Protection Area (EPA)

EAA phosphorus concentration during the base condition (1979 – 1988) was 173 µg/L

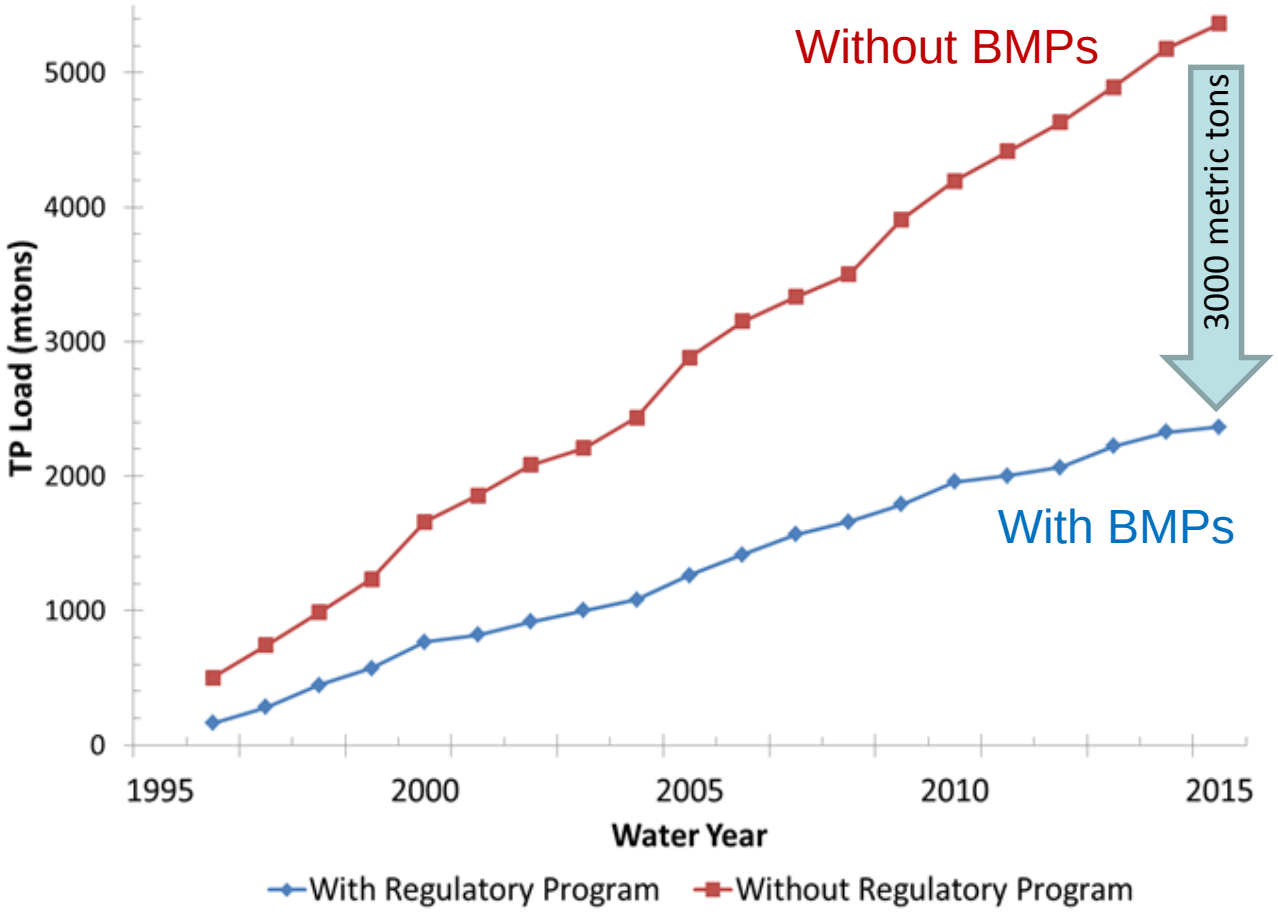


Everglades Agricultural Area
Best Management Practices (BMP) Success

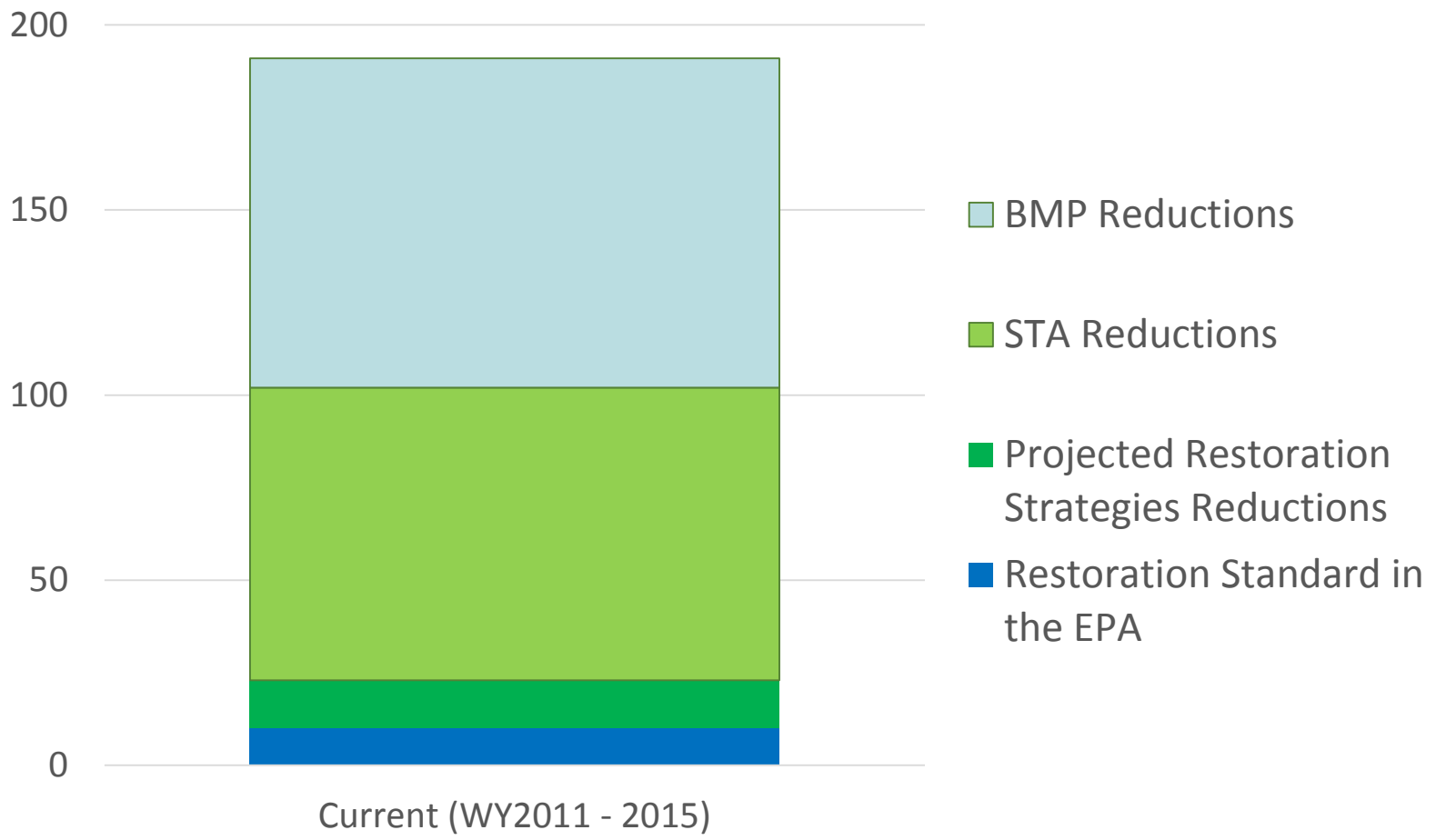


Everglades Agricultural Area
Phosphorus Load Reduction Achieved

BMPs prevented 3,000 metric tons of phosphorus from entering STAs



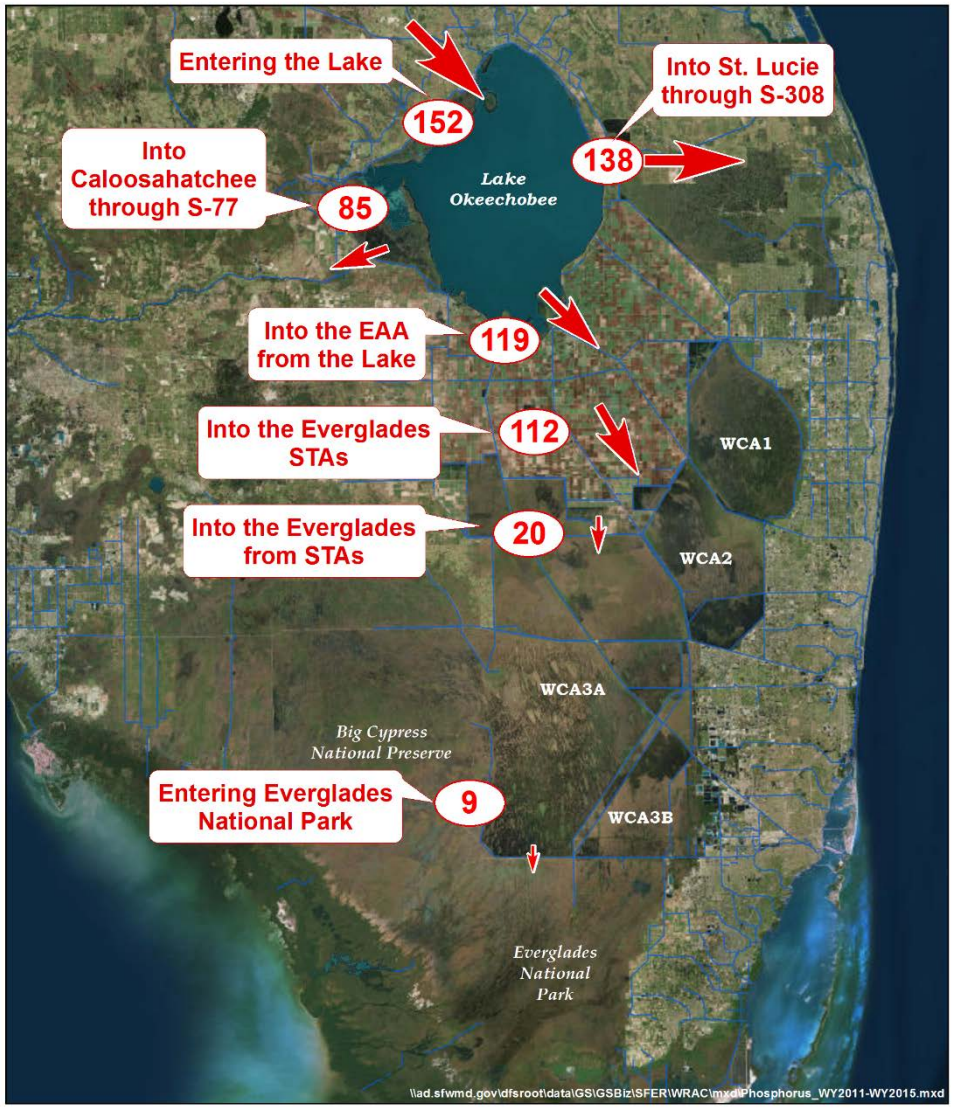
Everglades Agricultural Area
Reductions in Phosphorus since EFA



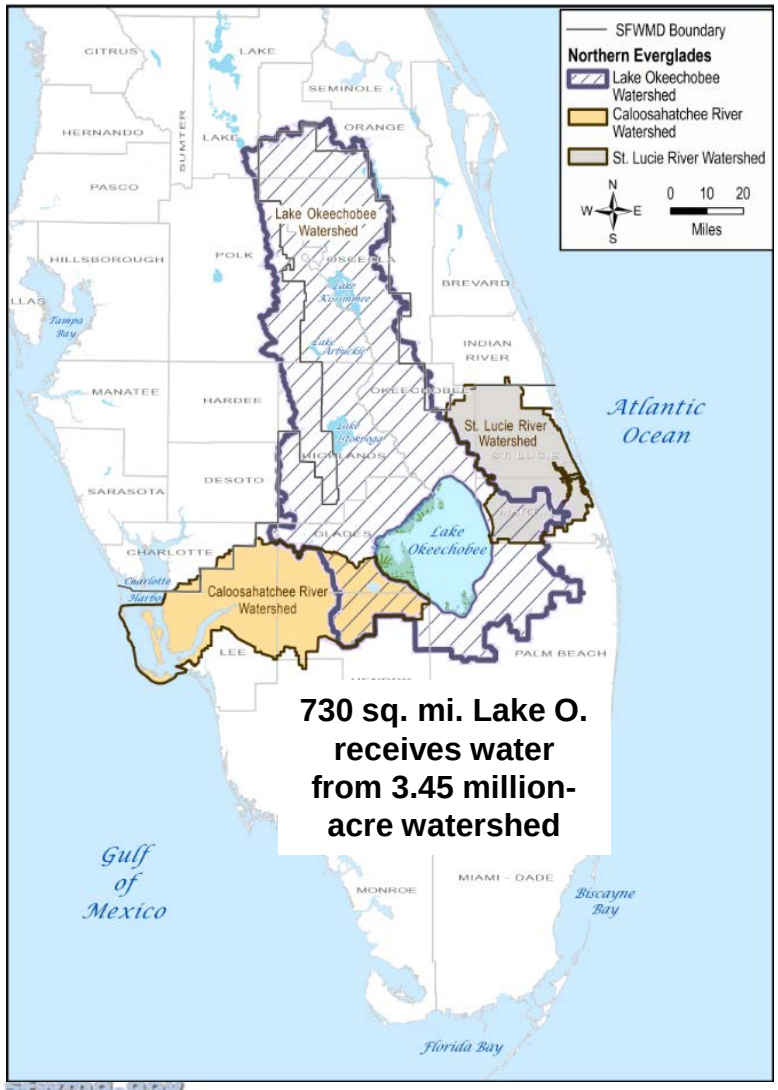
Phosphorus in the Everglades Watershed
WY2011 to WY2015

Current Condition

- Flow-weighted mean TP concentrations decrease from North to South
- Everglades Stormwater Treatment Areas (STA's) treat runoff from additional areas beyond the EAA



Northern Everglades
Lake Okeechobee, St. Lucie & Caloosahatchee River Watersheds

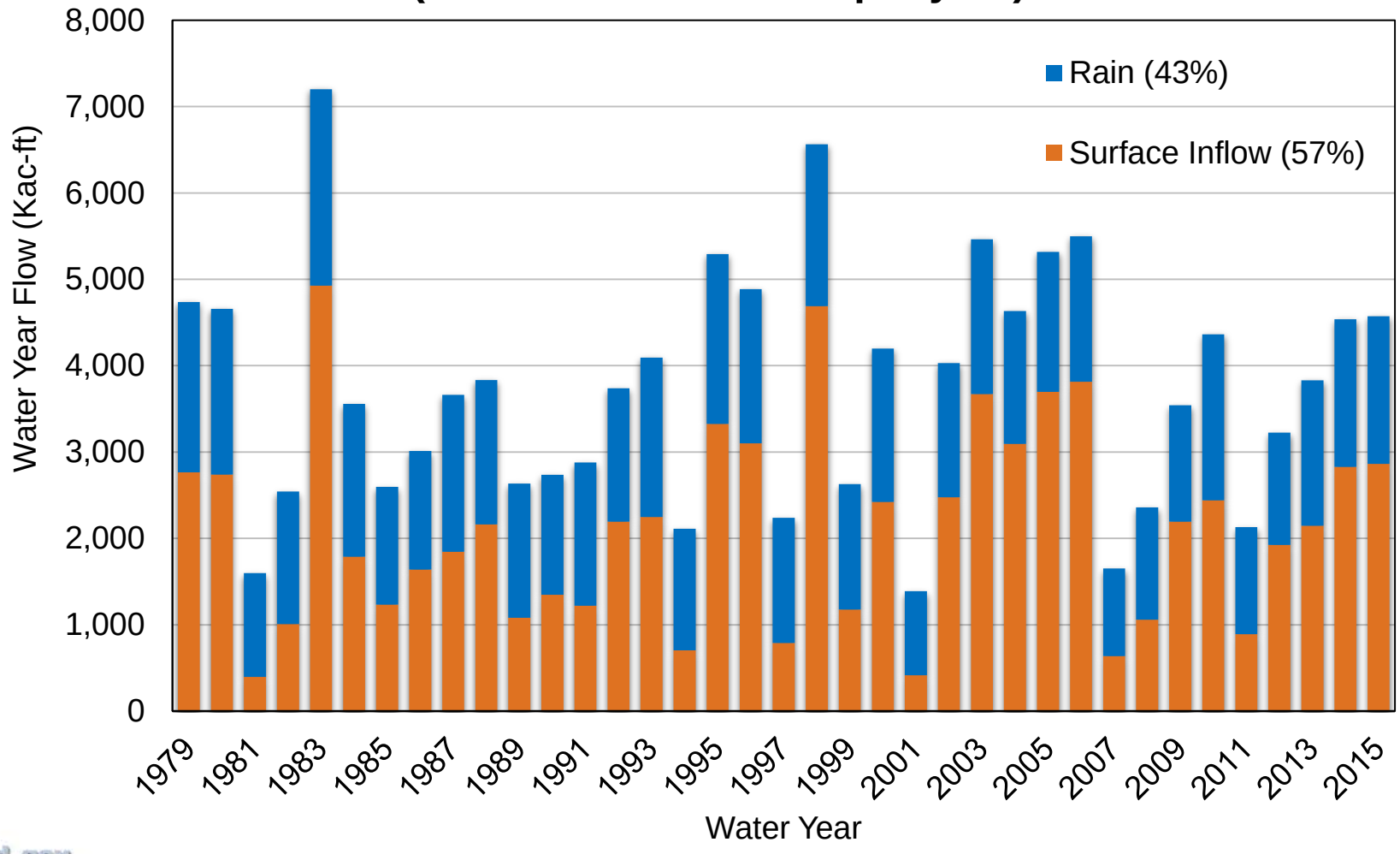


730 sq. mi. Lake O. receives water from 3.45 million-acre watershed

- 2007: Northern Everglades and Estuaries Protection Program (NEEPP) – Expands Northern Everglades to include River/Estuary Watersheds
- NEEPP also expands the focus beyond water quality to water quantity and habitat restoration
- Three key goals of NEEPP:
  1) Achieve Total Maximum Daily Loads (TMDLs)
  2) Maintain lake levels with desirable range
  3) Maintain desirable salinity balance in estuaries
- Watershed Protection Plans are the basis for the state's Basin Management Action Plans (BMAPs) (adopted in 2012 Caloosahatchee, 2013 St. Lucie, 2014 Lake Okeechobee)

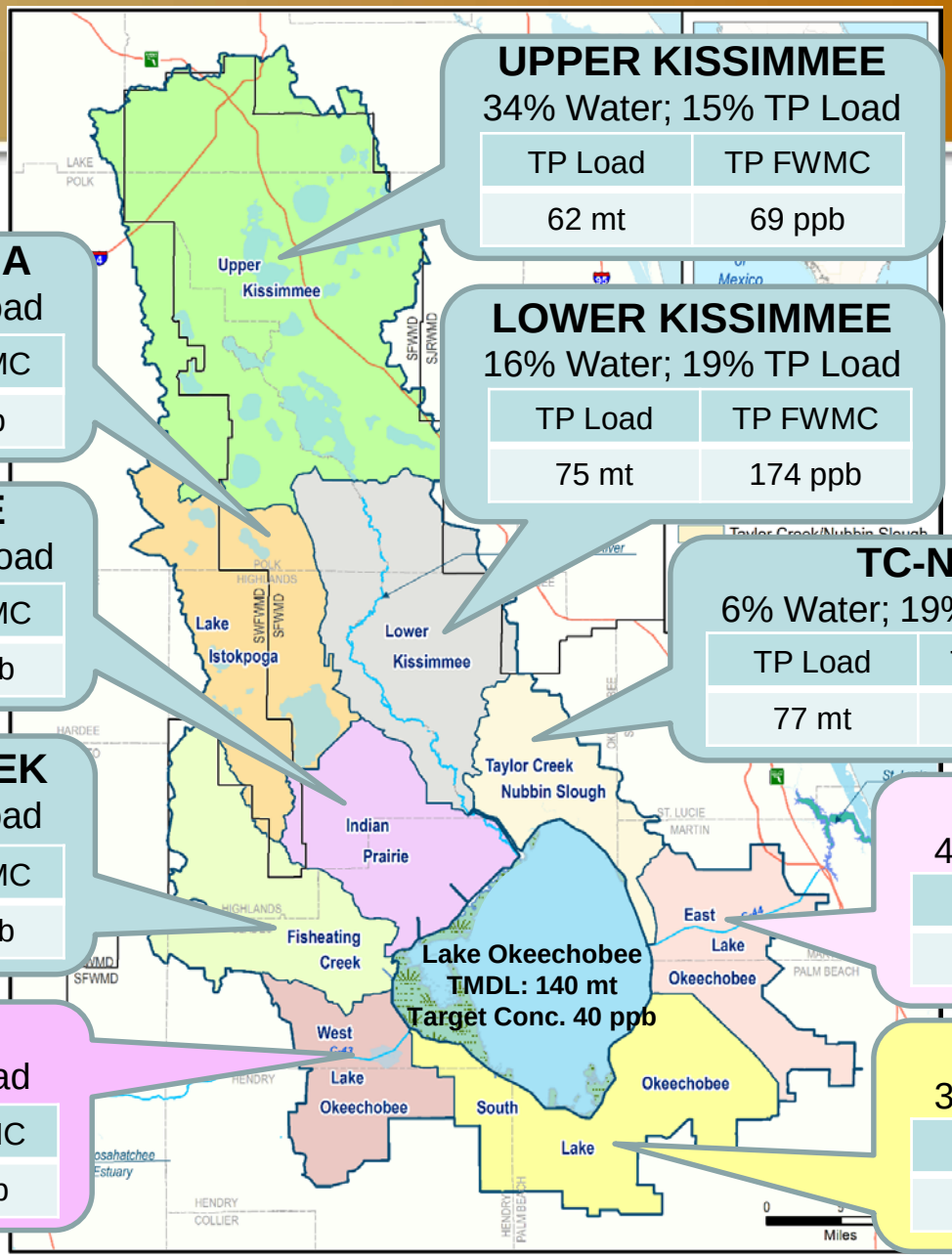
Lake Okeechobee Annual Inflows WY1979-2015

Surface Inflow to Lake Okeechobee historically varies over a wide range (0.5 to 5.0 million ac-ft per year)



Northern Everglades Lake Okeechobee Inflow

WY2011-WY2015 Phosphorus



UPPER KISSIMMEE
34% Water; 15% TP Load

TP Load	TP FWMC
62 mt	69 ppb

LOWER KISSIMMEE
16% Water; 19% TP Load

TP Load	TP FWMC
75 mt	174 ppb

LAKE ISTOKPOGA
13% Water; 6% TP Load

TP Load	TP FWMC
26 mt	75 ppb

INDIAN PRAIRIE
13% Water; 19% TP Load

TP Load	TP FWMC
78 mt	232 ppb

TC-NS
6% Water; 19% TP Load

TP Load	TP FWMC
77 mt	456 ppb

FISHEATING CREEK
9% Water; 11% TP Load

TP Load	TP FWMC
43 mt	181 ppb

EAST LAKE O.
4% Water; 4% TP Load

TP Load	TP FWMC
16 mt	154 ppb

WEST LAKE O.
2% Water; 2% TP Load

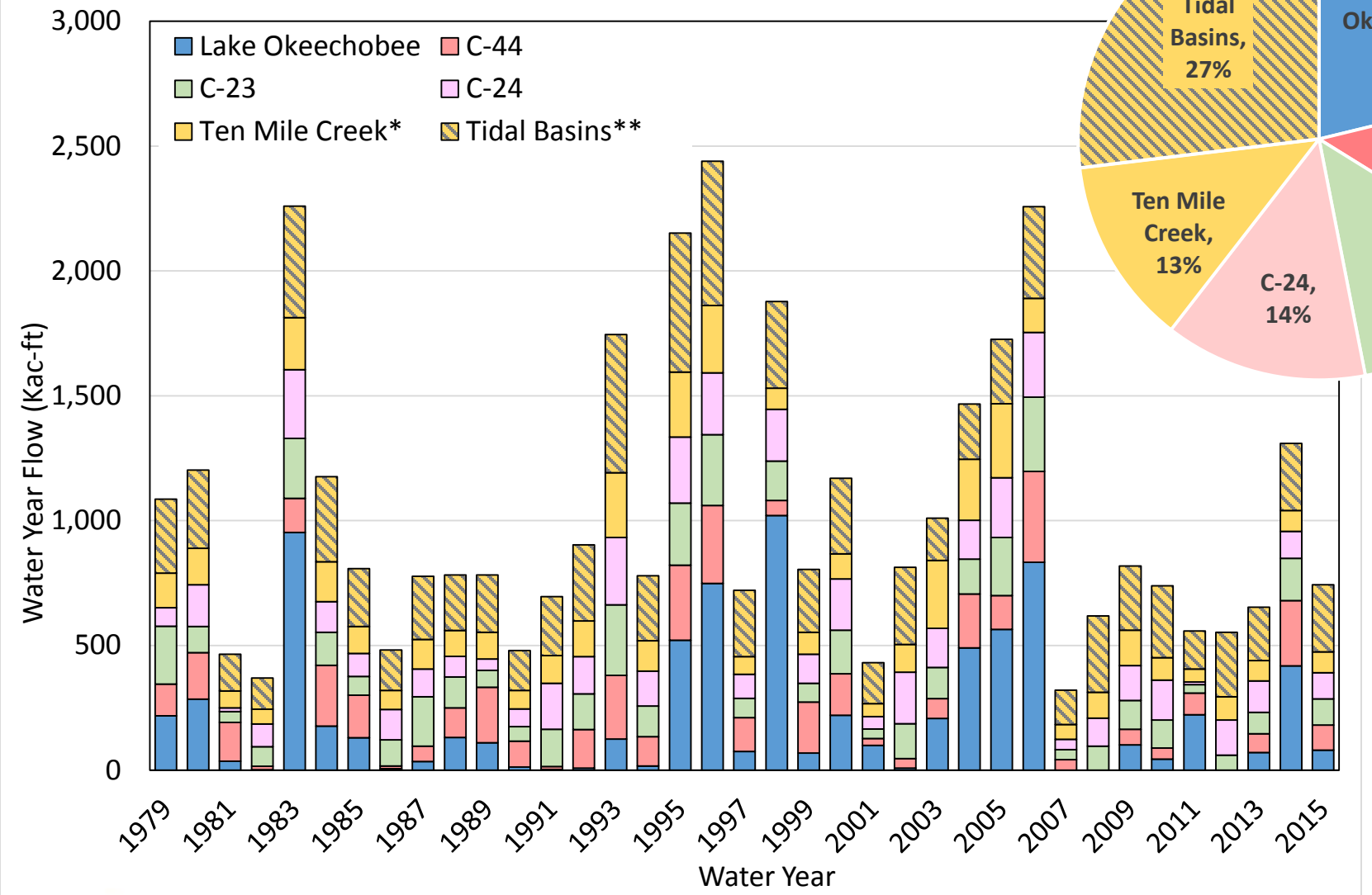
TP Load	TP FWMC
8 mt	146 ppb

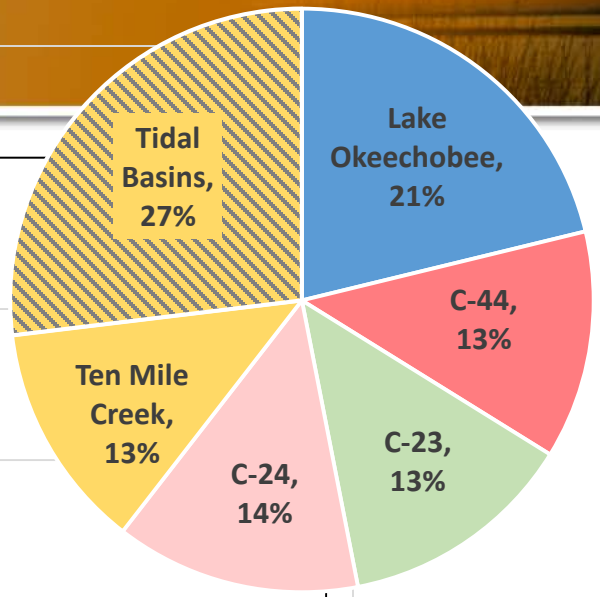
SOUTH LAKE O.
3% Water; 4% TP Load

TP Load	TP FWMC
15 mt	220 ppb

Northern watershed contributes ~ 90% of flow and TP load

St Lucie Estuary Annual Inflows WY1979-2015





Note: Inflows modeled and estimated from Tidal Basins entire period and Ten Mile Creek prior to WY2006.

Northern Everglades
St Lucie Estuary Inflow WY2011-WY2015
Phosphorus

Local Basin Runoff accounted for about 79% of flow and 87% of TP load to Estuary.

TEN MILE CREEK
10% Water; 10% TP Load

TP Load	TP FWMC
22 mt	224 ppb

C-24
13% Water; 19% TP Load

TP Load	TP FWMC
39 mt	321 ppb

C-23
12% Water; 23% TP Load

TP Load	TP FWMC
48 mt	432 ppb

LAKE OKEECHOBEE
21% Water; 13% TP Load

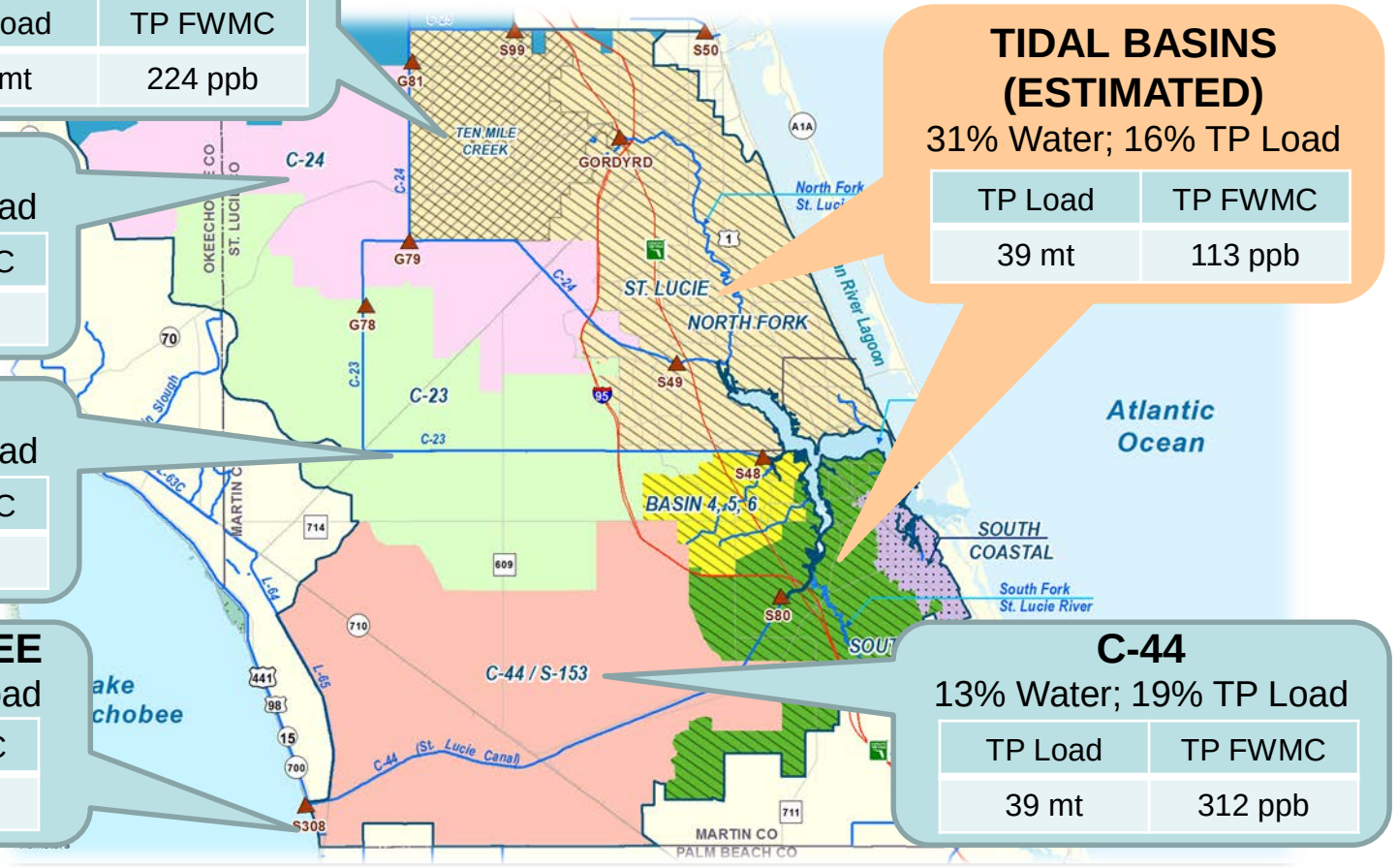
TP Load	TP FWMC
27 mt	138 ppb

TIDAL BASINS (ESTIMATED)
31% Water; 16% TP Load

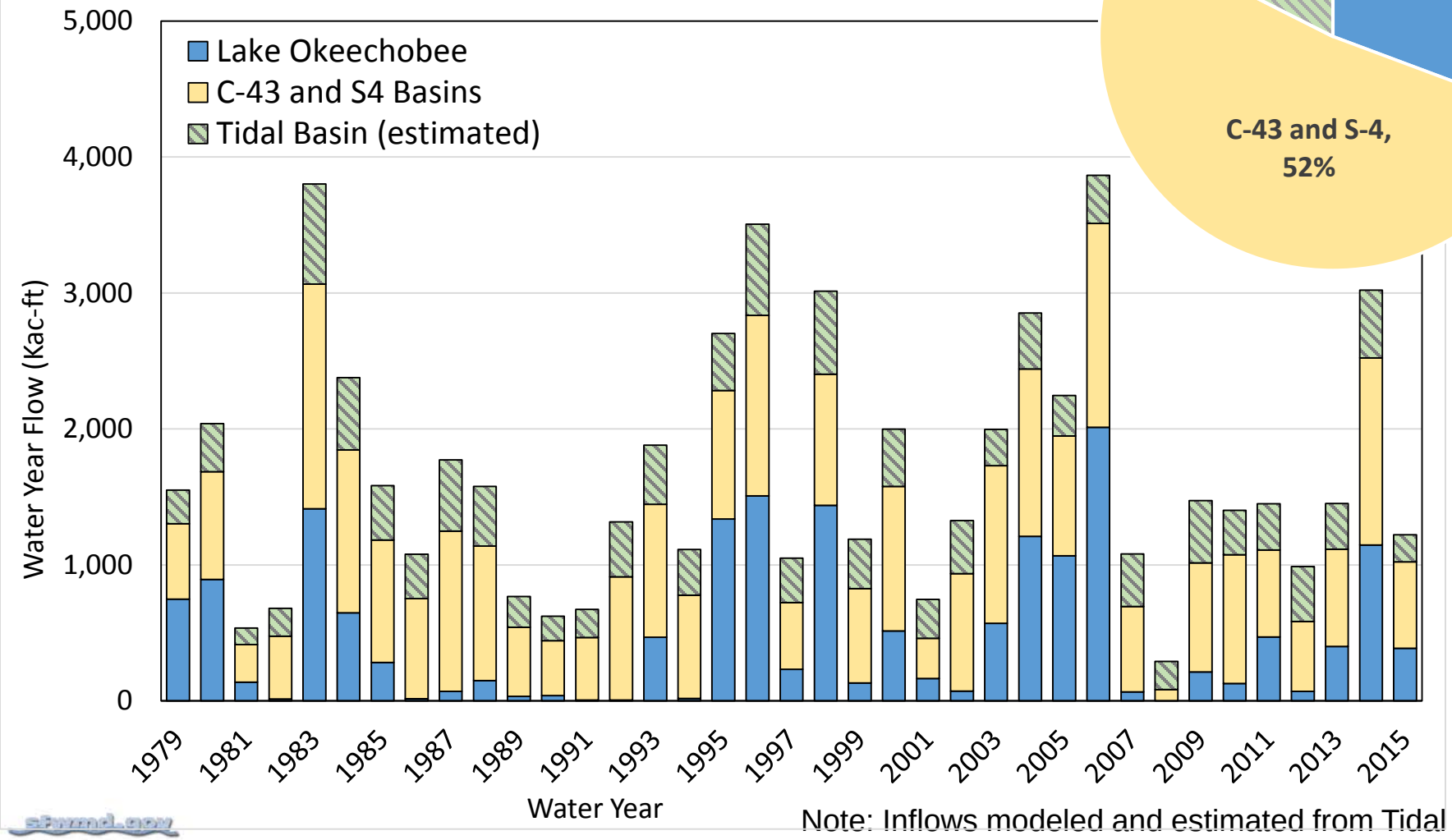
TP Load	TP FWMC
39 mt	113 ppb

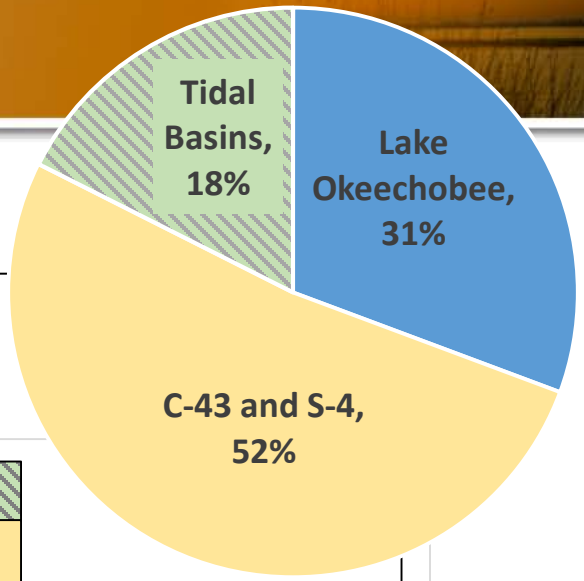
C-44
13% Water; 19% TP Load

TP Load	TP FWMC
39 mt	312 ppb



Caloosahatchee Estuary Annual Inflows (WY1979-2015)





Note: Inflows modeled and estimated from Tidal Basin.

Northern Everglades
Caloosahatchee Estuary Inflows WY2011-15
Phosphorus

Local Basin Runoff accounted for about 69% of flow and 77% of TP load to Estuary

TIDAL BASIN (ESTIMATED)
21% Water; 15% P Load

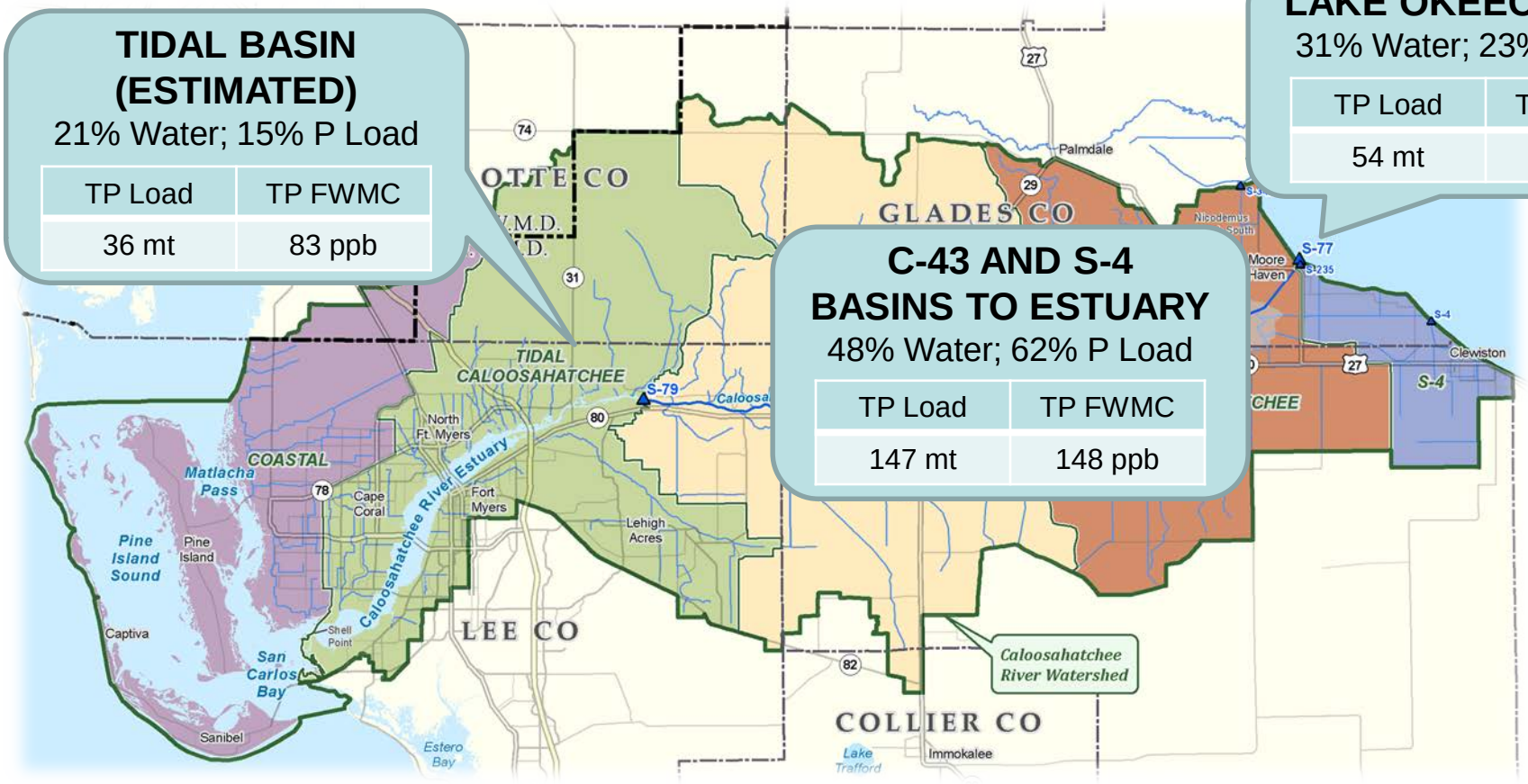
TP Load	TP FWMC
36 mt	83 ppb

LAKE OKEECHOBEE
31% Water; 23% P Load

TP Load	TP FWMC
54 mt	85 ppb

C-43 AND S-4 BASINS TO ESTUARY
48% Water; 62% P Load

TP Load	TP FWMC
147 mt	148 ppb



Notes: Coastal Basin runoff (west of Shell Point) is not included as Estuary contribution
Tidal Basin runoff flow modeled and TP estimated from representative data

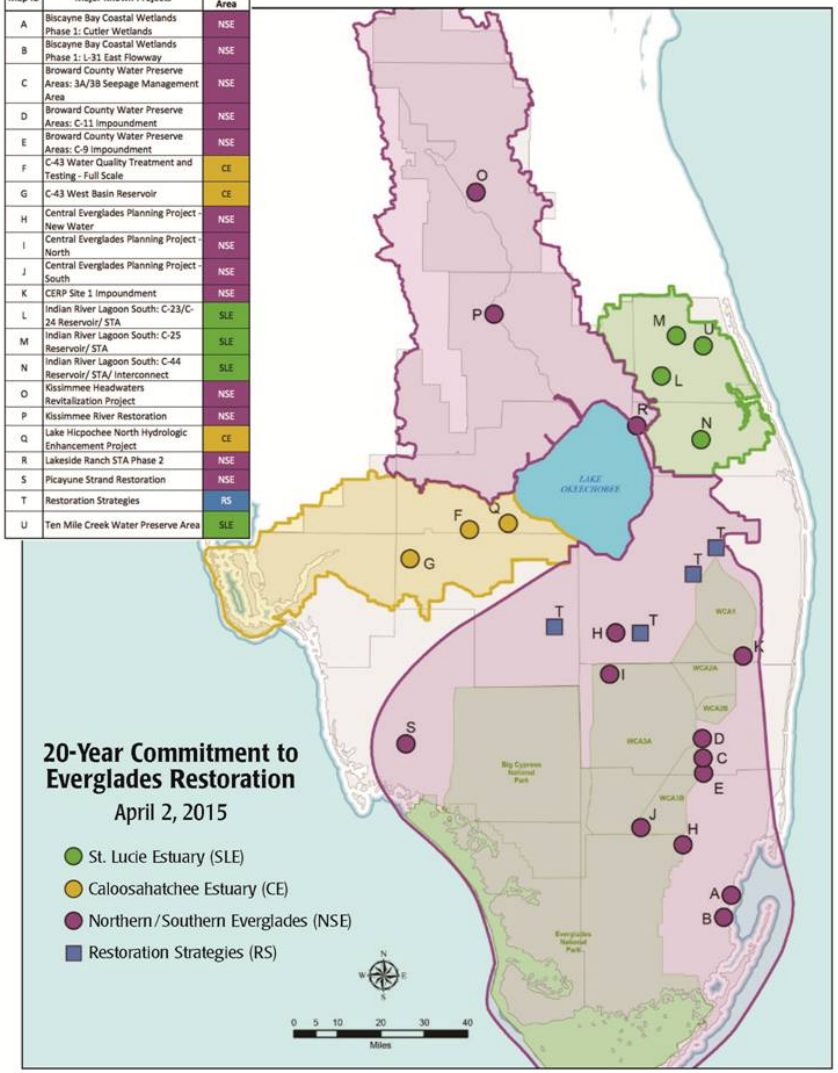
Summary

- **Southern Everglades:** >95% of area currently meets the 10 ppb water quality standard.
  - **EAA:** Need to fully implement “Restoration Strategies Plan” to achieve 100% compliance with the 10 ppb standard.
  - **Everglades Protection Area:** Fulfill goal of completing Modified Water Delivery Plan and CEPP Plan to help achieve TP standards and to improve the timing and distribution of water flow.

- **Northern Everglades:** Basin Management Action Plans (BMAPs) are overarching water quality restoration plans. Improving water quality and providing storage are key for restoration.
  - **Lake Okeechobee:** Inflows from the north (2.64 million acres or 4,131 square miles) contribute majority (~90 percent) of Lake inflows. Significant storage volumes north of lake are necessary to achieve healthier lake levels and reduce harmful discharges to estuaries.
  - **St Lucie Estuary:** Complete Indian River Lagoon and C-44 projects to reduce high TP discharges from local basin to estuary. At present, St Lucie watershed runoff has one of the highest TP concentrations in SFWMD’s 16 county area, and reductions are needed to help restore estuary.
  - **Caloosahatchee Estuary:** Complete C-43, Lake Hicpochee, Boma, and Nicodemus Slough projects, as well as other local projects, to provide storage and reduce TP discharges from local runoff to help restore estuary.

Governor Scott's Plan

Map ID	Major Known Projects	Project Area
A	Biscayne Bay Coastal Wetlands Phase 1: Cutler Wetlands	NSE
B	Biscayne Bay Coastal Wetlands Phase 1: L-31 East Flowway	NSE
C	Broward County Water Preserve Areas: 3A/3B Seepage Management Area	NSE
D	Broward County Water Preserve Areas: C-11 Impoundment	NSE
E	Broward County Water Preserve Areas: C-9 Impoundment	NSE
F	C-43 Water Quality Treatment and Testing - Full Scale	CE
G	C-43 West Basin Reservoir	CE
H	Central Everglades Planning Project - New Water	NSE
I	Central Everglades Planning Project - North	NSE
J	Central Everglades Planning Project - South	NSE
K	CERP Site 1 Impoundment	NSE
L	Indian River Lagoon South: C-23/C-24 Reservoir/ STA	SLE
M	Indian River Lagoon South: C-25 Reservoir/ STA	SLE
N	Indian River Lagoon South: C-44 Reservoir/ STA/ Interconnect	SLE
O	Kissimmee Headwaters Revitalization Project	NSE
P	Kissimmee River Restoration	NSE
Q	Lake Hicpochee North Hydrologic Enhancement Project	CE
R	Lakeside Ranch STA Phase 2	NSE
S	Picayune Strand Restoration	NSE
T	Restoration Strategies	RS
U	Ten Mile Creek Water Preserve Area	SLE



At a Glance

- Governor Scott has proposed a dedicated source of funding for Everglades restoration over the next 20 years.

  The Governor's plan includes $5 billion in state funding and $4 billion in anticipated matching funds from the federal government.

- The plan will continue the momentum of Florida's job growth and provide for steady and consistent progress on Everglades restoration.

- Implementation of the Governor's plan will deliver these critical benefits to the Everglades ecosystem:

  Capture and store 1 million acre-feet (330 billion gallons) of fresh water, which will significantly decrease the frequency and intensity of harmful freshwater discharges to the northern estuaries.

  Reduce phosphorus loads to Lake Okeechobee, Caloosahatchee Estuary, St Lucie Estuary and the Everglades by 252 metric tons per year.

Discussion

Summary of Revisions 12/23/15 Following WRAC November 5, 2015

The following revisions were made to this presentation to address comments received at the November 5, 2015, WRAC meeting:

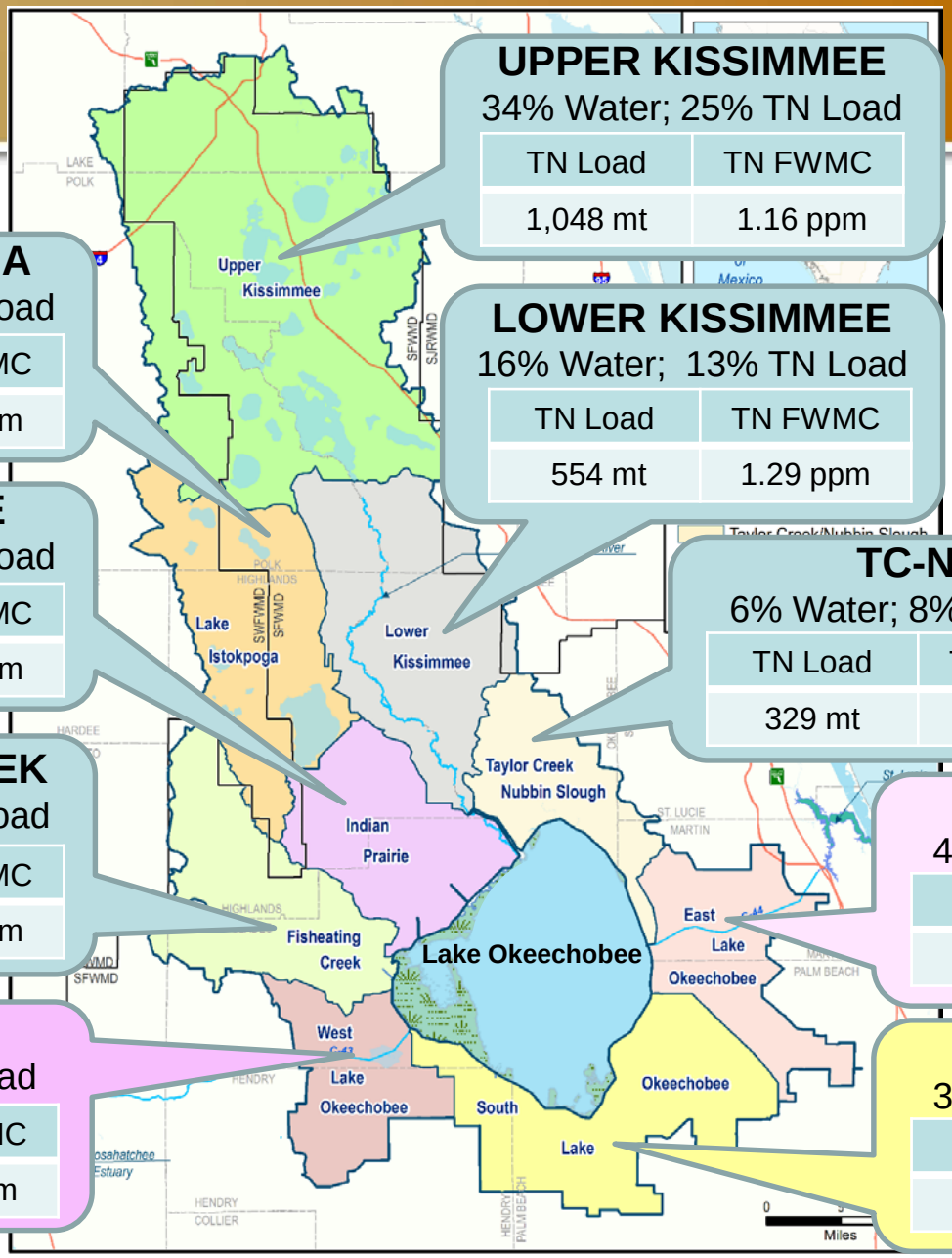
- Minor editorial changes not listed here
- Southern Everglades Exceedances in the Everglades (Loxahatchee Refuge) original slide 10 split into new slides 10, 11, and 12.
  - Refuge Map and Applicable TP Criteria overview (Federal Consent Decree and State TP Rule)
  - Federal Consent Decree – added data to quantify deviation from Long-term Level (criteria)
  - State TP Rule – added 2015 geo-means and 4-part compliance test table
- Southern Everglades Exceedances in the Everglades (Shark River Slough)
  - Added Table of 2008, 2012 and 2014 Exceedance Event TP Differences
- Northern Everglades – Re-ordered inflow volume charts before TP inflow maps
- St Lucie and Caloosahatchee – updated annual inflow charts
  - Added estimated tidal basin inflows to estuaries and corrected C-23 missing data prior to 1996
  - Added pie chart of period-of-record inflow volume percentages by basin

Supplemental Nitrogen Information

- The following three slides representing 5-year average levels of total nitrogen within the Northern Everglades watersheds are provided in response to WRAC member comments on November 5, 2015.
- These slides are to be incorporated to a presentation at a future WRAC meeting.

Northern Everglades Lake Okeechobee Inflow

WY2011-WY2015 Nitrogen



UPPER KISSIMMEE
34% Water; 25% TN Load

TN Load	TN FWMC
1,048 mt	1.16 ppm

LOWER KISSIMMEE
16% Water; 13% TN Load

TN Load	TN FWMC
554 mt	1.29 ppm

LAKE ISTOKPOGA
13% Water; 13% TN Load

TN Load	TN FWMC
530 mt	1.54 ppm

INDIAN PRAIRIE
13% Water; 18% TN Load

TN Load	TN FWMC
728 mt	2.16 ppm

TC-NS
6% Water; 8% TN Load

TN Load	TN FWMC
329 mt	1.94 ppm

FISHEATING CREEK
9% Water; 10% TN Load

TN Load	TN FWMC
401 mt	1.71 ppm

EAST LAKE O.
4% Water; 5% TN Load

TN Load	TN FWMC
198 mt	1.90 ppm

WEST LAKE O.
2% Water; 2% TN Load

TN Load	TN FWMC
89 mt	1.61 ppm

SOUTH LAKE O.
3% Water; 6% TN Load

TN Load	TN FWMC
265 mt	3.80 ppm

Northern watershed contributes:
~ 91% of flow and
~ 87% TN load

Northern Everglades
St Lucie Estuary Inflow WY2011-WY2015
Nitrogen

Local Basin Runoff accounted for about 79% of flow and 79% of TN load to Estuary.

TEN MILE CREEK
10% Water; 8% TN Load

TN Load	TN FWMC
96 mt	0.99 ppm

C-24
13% Water; 17% TN Load

TN Load	TN FWMC
195 mt	1.62 ppm

C-23
12% Water; 16% TN Load

TN Load	TN FWMC
186 mt	1.66 ppm

LAKE OKEECHOBEE
21% Water; 21% TN Load

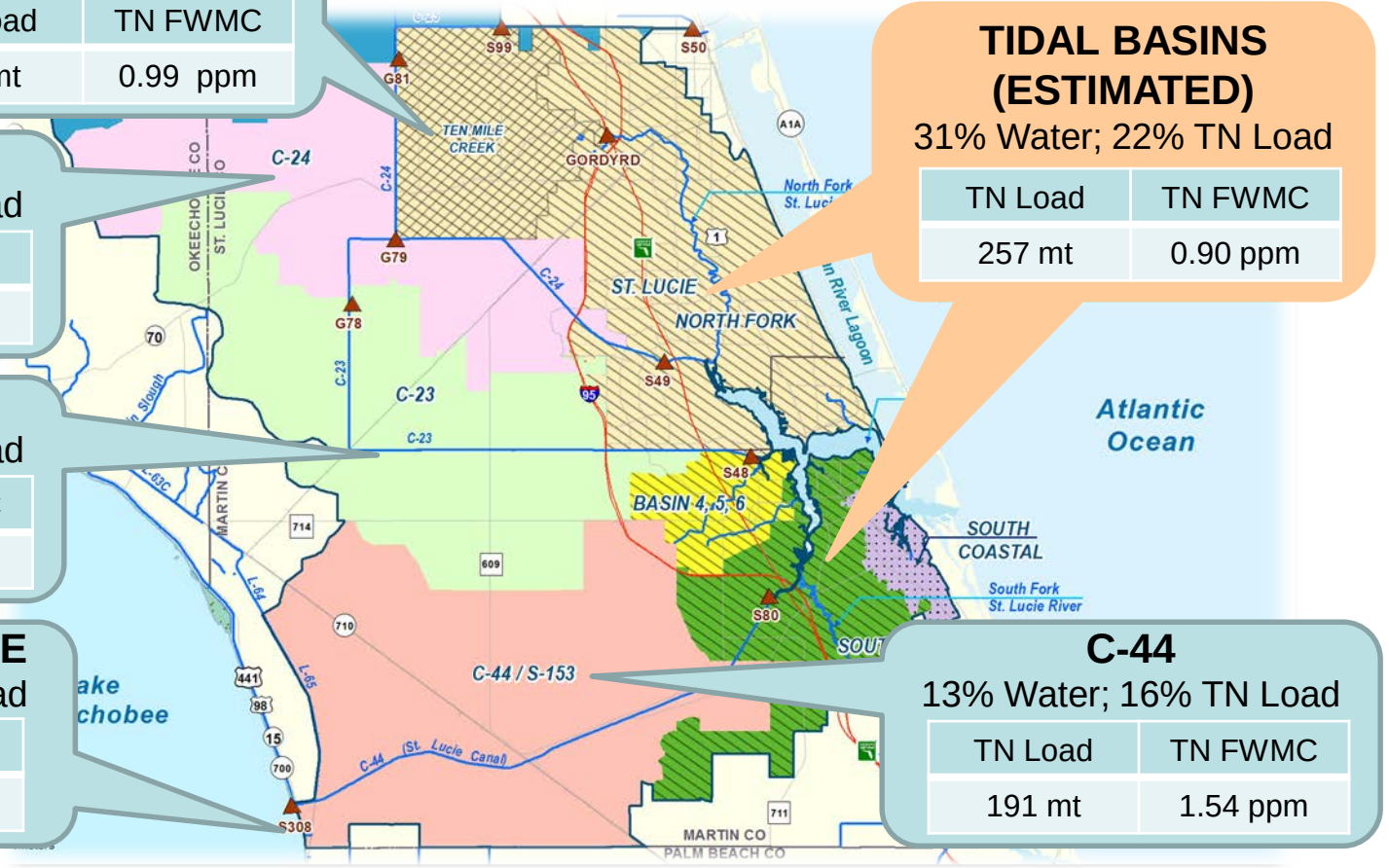
TN Load	TN FWMC
249 mt	1.29 ppm

TIDAL BASINS (ESTIMATED)
31% Water; 22% TN Load

TN Load	TN FWMC
257 mt	0.90 ppm

C-44
13% Water; 16% TN Load

TN Load	TN FWMC
191 mt	1.54 ppm



Northern Everglades
Caloosahatchee Estuary Inflows WY2011-15
Nitrogen

Local Basin Runoff accounted for about 69% of flow and 68% of TN load to Estuary

TIDAL BASIN (ESTIMATED)
21% Water; 20% TN Load

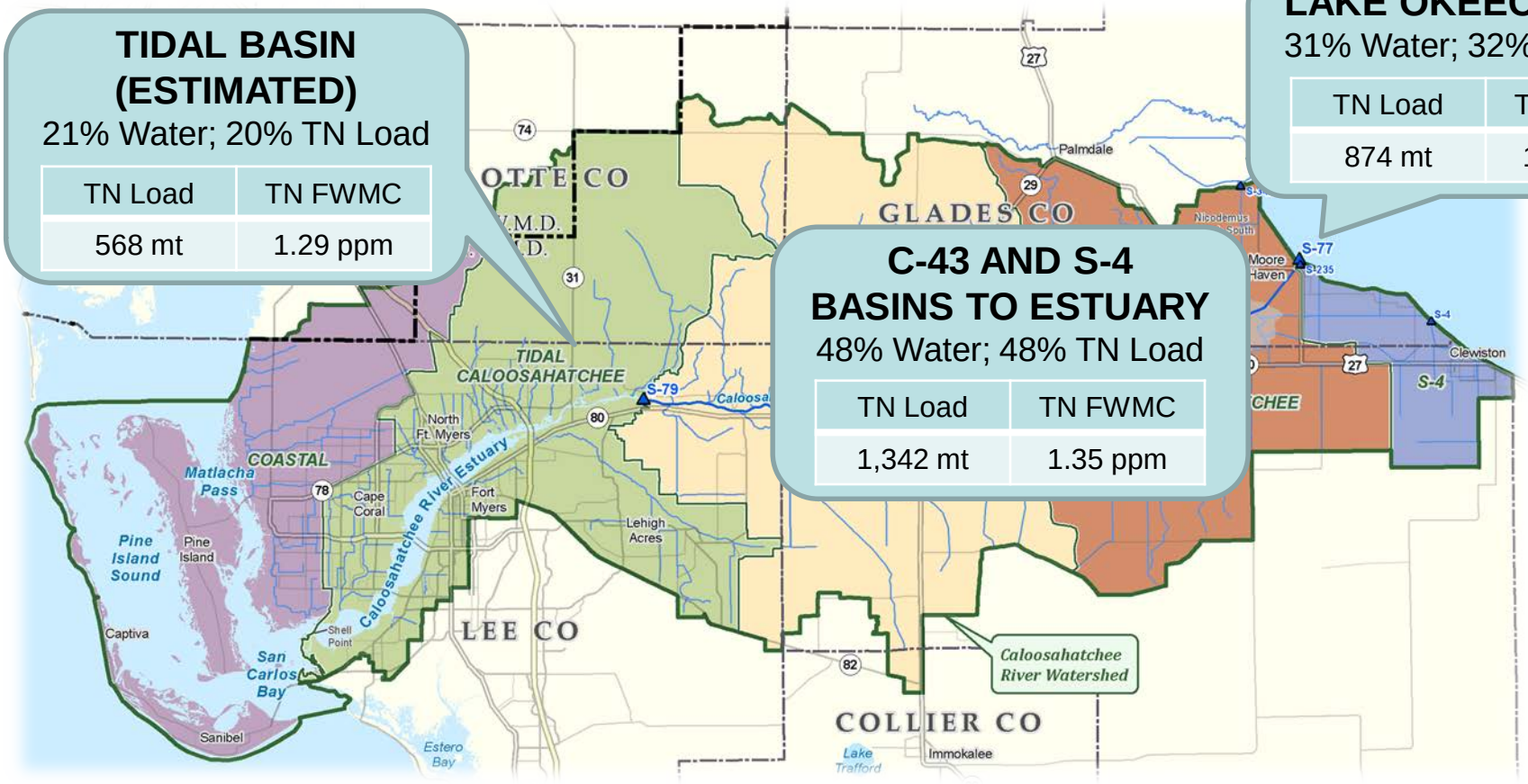
TN Load	TN FWMC
568 mt	1.29 ppm

LAKE OKEECHOBEE
31% Water; 32% TN Load

TN Load	TN FWMC
874 mt	1.36 ppm

C-43 AND S-4 BASINS TO ESTUARY
48% Water; 48% TN Load

TN Load	TN FWMC
1,342 mt	1.35 ppm



Note: Coastal Basin runoff (west of Shell Point) is not included as Estuary contribution.